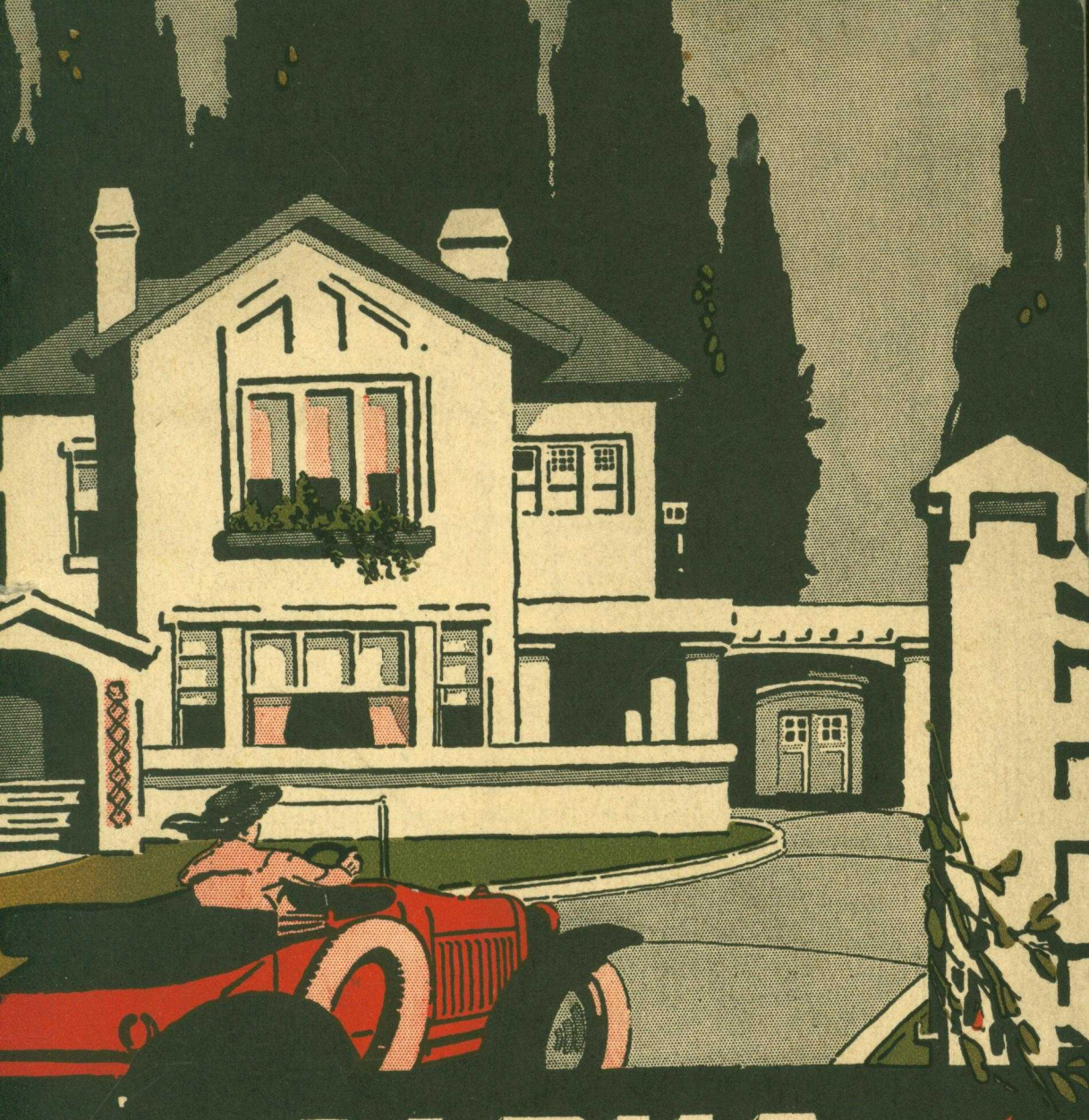
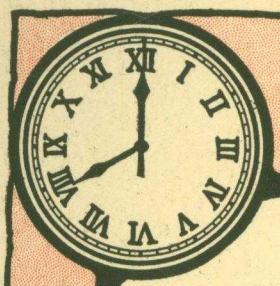


ALPHA

THE GUARANTEED PORTLAND

CEMENT

How to use it

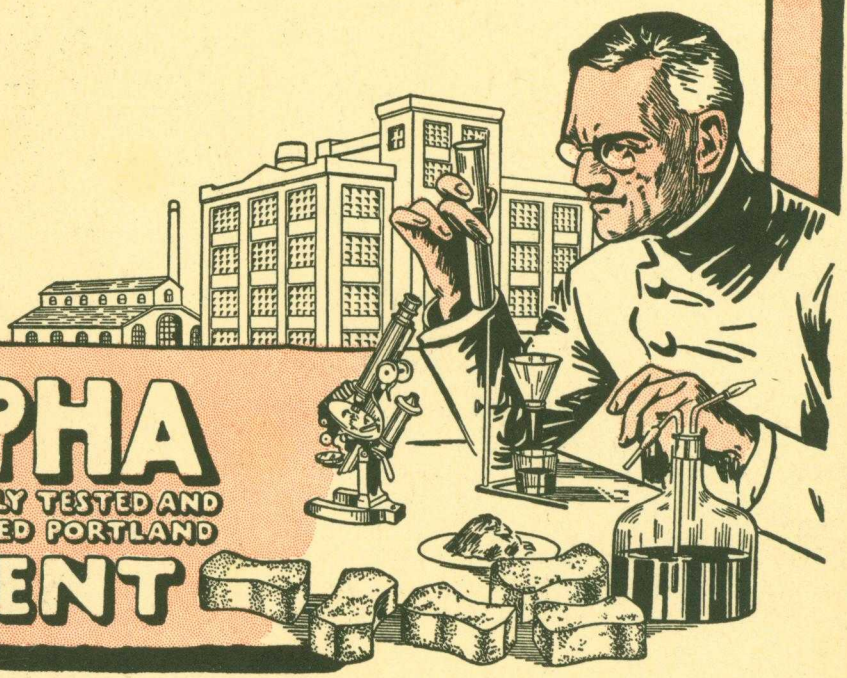


TESTS EVERY HOUR DAY AND NIGHT

UNIFORMITY is a prime requisite of cement. When the proportions for the concrete have been fixed upon, it is necessary that every bag of the cement used be up to a high standard of quality.

The uniformity of ALPHA CEMENT is safeguarded by systematic testing which begins with quarry borings. These tests by expert chemists are applied hourly at every ALPHA plant. The ALPHA policy is to make its chemists men of real authority. Their decisions as to quality are absolute. The result is that it is practically impossible for any cement that will not set properly to be shipped from an ALPHA plant. Every bag is guaranteed—and stamped "Guaranteed"—invariably to meet standard specifications.

Test ALPHA if you prefer, but you don't have to.



ALPHA

THE HOURLY TESTED AND GUARANTEED PORTLAND

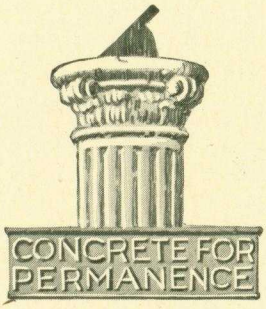
CEMENT

#40694

ALPHA THE GUARANTEED PORTLAND CEMENT

HOW TO USE IT

C. W. LEFFLER & SON
MARION, OHIO.



ALPHA PORTLAND CEMENT COMPANY

EASTON, PA. **CHICAGO, ILL., (140 S. Dearborn St.)**

NEW YORK.....16 East 43rd Street
BOSTON.....Board of Trade Building
PITTSBURGH.....Oliver Building
BALTIMORE.....Builders' Exchange
BATTLE CREEK, MICH.....Post Building
IRONTON.....Ohio
PHILADELPHIA.....Harrison Building
ST. LOUIS.....1225 Arcade Building

PLANTS AT

Alpha, N. J.
La Salle, Ill.
Martins Creek, Pa.
Jamesville, N. Y.
Manheim, W. Va.
Ironton, Ohio
Cementon, N. Y.
Bellevue, Mich.
St. Louis, Mo.

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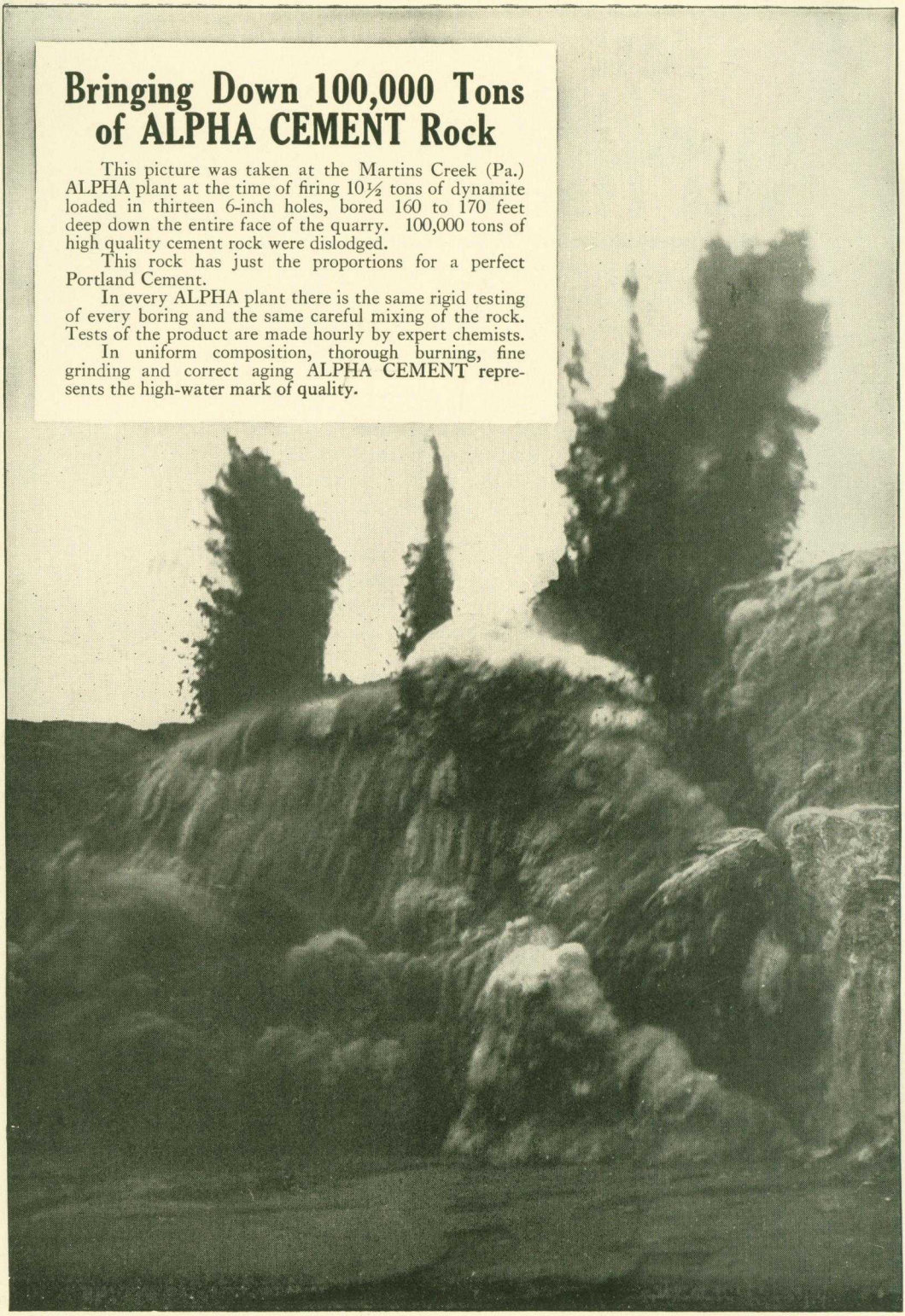
Bringing Down 100,000 Tons of ALPHA CEMENT Rock

This picture was taken at the Martins Creek (Pa.) ALPHA plant at the time of firing 10½ tons of dynamite loaded in thirteen 6-inch holes, bored 160 to 170 feet deep down the entire face of the quarry. 100,000 tons of high quality cement rock were dislodged.

This rock has just the proportions for a perfect Portland Cement.

In every ALPHA plant there is the same rigid testing of every boring and the same careful mixing of the rock. Tests of the product are made hourly by expert chemists.

In uniform composition, thorough burning, fine grinding and correct aging ALPHA CEMENT represents the high-water mark of quality.



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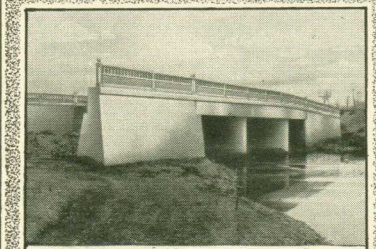
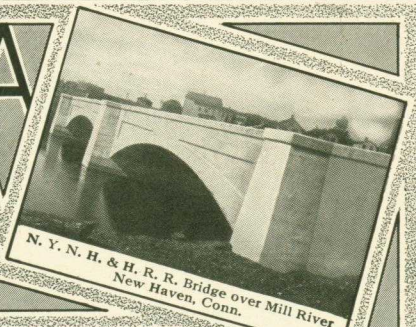
Bridge over Connecticut River—Hartford, Conn
ALPHA CEMENT used exclusively
125,000 Barrels



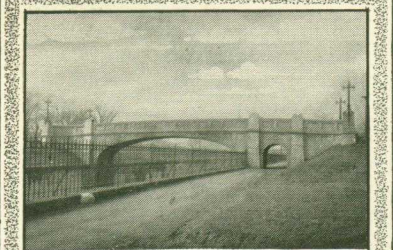
Humphrey St. Bridge—New Haven, Conn.
ALPHA CEMENT used exclusively

Union Railroad Bridge—East Pittsburgh, Pa.
ALPHA CEMENT used exclusively

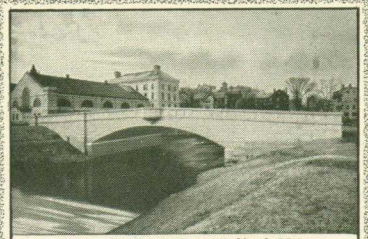


N. Y. N. H. & H. R. R. Bridge over Mill River
New Haven, Conn.

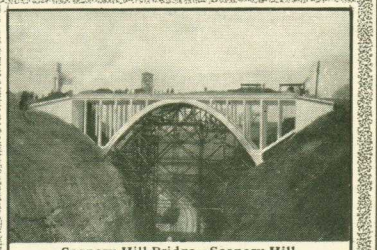
Auburn St. Bridge—West Medford, Mass
ALPHA CEMENT used exclusively



Foot-bridge over Pennsylvania R. R. Tracks
in Allegheny Park—Allegheny, Pa.



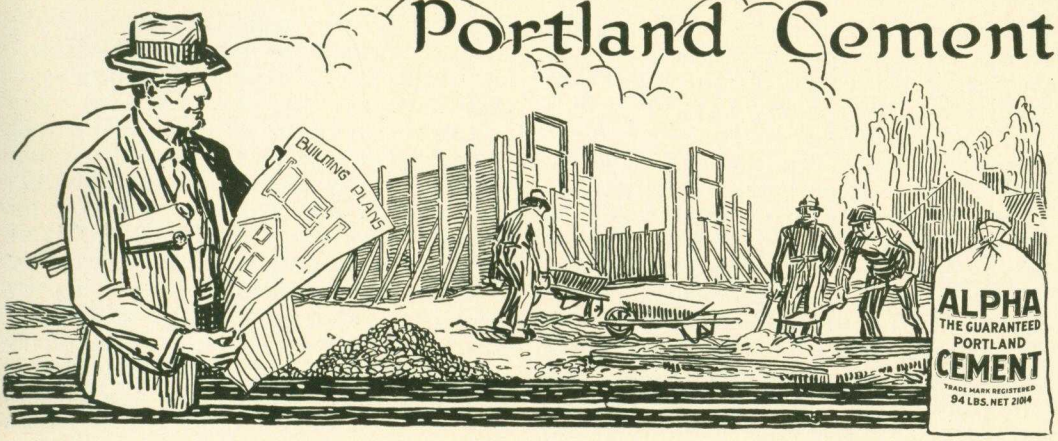
Armory Bridge—West Medford, Mass.
ALPHA CEMENT used exclusively



Scenery Hill Bridge—Scenery Hill,
Washington County, Pa.

Some Everlasting ALPHA CEMENT Bridges

Cement Construction and Portland Cement



THE WORD "CONCRETE" refers to sand and pebbles or crushed stone, or other hard material such as slag, hard cinder, broken brick, etc., which has been thoroughly mixed with Portland Cement and water and allowed to harden.

Portland Cement is the most tenacious binding material or mortar known. When properly mixed with the other materials named, it binds with a grip that makes the entire mass as hard and imperishable as if it were cut from solid stone. This "manufactured stone" has rapidly become the principal building material, where strength, durability, and protection against fire, water, rats, etc., are essential.

As concrete requires, in addition to cement, only the most commonplace and easily procured materials—sand, stone, and water—and is simply made, being merely mixed thoroughly, cast in place, and allowed to remain in forms until the hardening takes place, cement construction has a wonderful growth. Its earliest general use was in great engineering undertakings—bridges, retaining walls, sea walls, and the like, but now that the advantages of cement work have become universally recognized, a great list of buildings and improvements, ranging from such small constructions as fence posts to the largest factories and warehouses, are being everywhere built "the everlasting way."

Why Cement is Called "Portland"

"Portland" is merely a generic name, such as "wrought" as applied to iron, or "Russia" or "sole" as applied to leather. The name was applied to this class of cement because, when Joseph Aspdin, of Leeds, England, discovered the method of making the cement, the product had a "fancied though really slight resemblance to the noted oolitic limestone from the Isle of Portland, on the South coast of England." That oolitic limestone, which by the way is used in the London Westminster Cathedral, was known as "Portland Stone"; hence it seemed natural to give the name "Portland Cement" to the new product that made stone resembling Portland Stone.

There are now almost as many different brands of Portland cement as there are brands of flour or lime.

Increase in Use of Portland Cement

Some idea of the widespread increase in the use of Portland Cement may be gained from the fact that 8,482,000 barrels were manufactured in America in 1900, while the present yearly output is close to 100,000,000 barrels. The United States at present leads all other countries in production, and cement is produced at many different points—with raw materials that vary according to the section of the country. Clay, limestone, marl, cement rock, etc., are used.

How "ALPHA" Cement is Made

The raw materials for cement-making contain lime, silica, alumina and still other constituents. These materials are excavated, weighed, dried, proportioned

with great care, and then ground to a fine powder. This ground raw material is then subjected to an intense heat, over 2500° F., in great rotary kilns, until it is "calcined to incipient fusion,"—to use the chemist's terms. The clinker formed by this process is again ground—this time to an impalpable powder—so that more than three-fourths of it will pass a screen containing 40,000 meshes to the square inch. This twice-ground and thoroughly burned fine powder is Portland Cement.

The best grade of Portland Cement mixed pure, gives a tensile strength on "standard tests" of from 600 to 800 pounds in 28 days, while natural cement, the strongest mortar material known up to the discovery of Portland Cement, reached only about 225 pounds. Moreover, concrete made of Portland Cement continues for months, probably for years, to gain strength. Just how long it continues to grow stronger is not definitely known, but it is sufficient to be assured that properly built cement structures are practically imperishable. They stand fire, water, and wear, eliminate painting and repairing; keep interiors cool in summer and warm in winter, are attractive and sanitary. With so many advantages, it is scarcely to be wondered at that cement construction is increasing by leaps and bounds.

Portland Cement hardens under water as well as out of it; hence it is doubly useful and makes easily possible structures that otherwise would present difficult problems.

"ALPHA" History and Policy

The Alpha Portland Cement Company was a pioneer manufacturer of American Portland Cement, and it came into the field in 1891, when first the English Portland Cements and later the German Portlands were regarded as being of the best quality. The original ALPHA equipment of two 40-foot kilns and the yearly output of 100,000 barrels seem indeed small when compared with the group of modern ALPHA plants now able to produce in a few days as much cement as the original plant produced in a year.

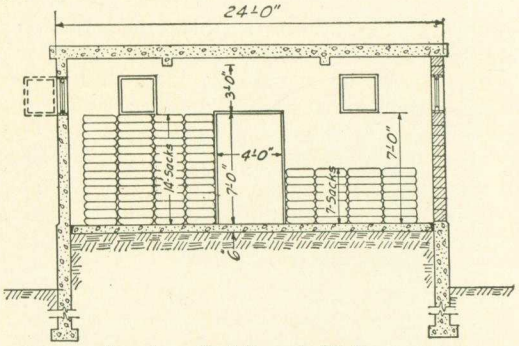
The ALPHA Company concluded in the beginning to make only one grade of Portland Cement and to have that of such a quality that it would be a credit to the company behind the brand. That policy has been continued through the thirty years that have now elapsed. Neither sharp competition nor zeal for impressive output at low cost has ever been allowed to lower the quality of ALPHA Portland CEMENT. And ALPHA Service is kept on a par with the high quality of ALPHA CEMENT.

Experience has shown that the policy of the Alpha Portland Cement Company is correct. More and more the discriminating buyer shows his appreciation of the product whose standard of quality is invariably high—that can be depended on whether the usual tests are applied or not.

How to Store Portland Cement

Portland Cement is sold nowadays mostly in cotton or paper bags containing 94 pounds net, which is approximately one cubic foot of cement. Shipment in barrels is confined almost entirely to export trade. Cotton bags are used a number of times and are bought back by cement manufacturers and dealers when in good condition, thus reducing package cost to the cement user. It is very important that cement to be stored any length of time prior to use shall be protected from moisture. Sacks or bags which have become wet are unsuited to further use as cement containers and are therefore not accepted for redemption.

Cement should — never — never be piled on the ground, which always contains some moisture. An improvised floor will protect cement.



Cross-section view of building suitable for cement storage. It may be of either monolithic concrete or cement block construction. Where it is not feasible to lay the floor on a gravel or cinder fill, the floor must be reinforced and carried by beams supported by cement piers, and the foundation wall should have openings that will permit free circulation of air beneath the floor. Footings should be to firm foundation below frost line

ALPHA CEMENT — HOW TO USE IT

The illustration on page 6 shows a cement storage shed of reinforced cement construction. Such a shed may also be built of cement block and if these block are of the usual hollow type the insulation thus provided will, with proper ventilation of the structure, make ideal storage. The illustration referred to shows also an approved method of piling sacks. If the cement is to be stored for a short time only, piles may be 12 or 15 sacks high, laid in header and stretcher fashion to prevent piles from overturning. If, however, storage is to be for long periods, it is recommended that piles be not more than 7 sacks high so as to minimize "warehouse setting" or caking. Ventilation should be provided for, but this does not mean that ventilation should be constant, because the reverse is distinctly true during periods of damp weather.

A permanent cement storage shed should have a cement floor, laid on a well drained fill of cinders or clean gravel. The concrete mixture should be not leaner than a 1:2:3 proportion in order to secure the density that will mean watertightness. Sacks should be piled closely but not in contact with building sidewalls. A 6-inch air space is sufficient unless more room is needed to provide more convenient access to windows for ventilation. No more free air space should be allowed in cement storage than necessary for working convenience.

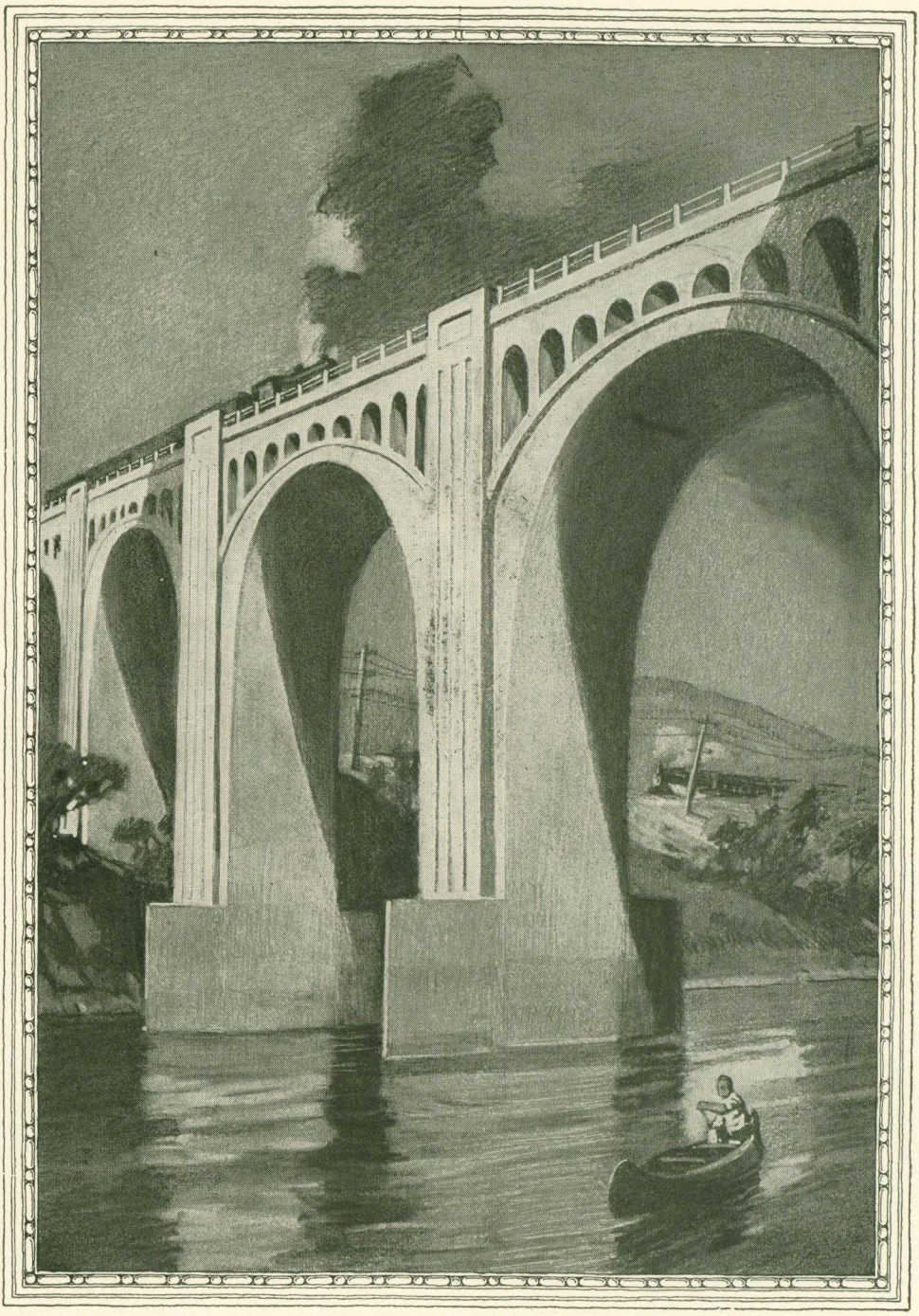
In a frame building, such as usually used for temporary cement storage a tight board floor placed well above the surrounding ground level may be used. This should be of double construction with tar or other moisture-proof paper laid between the two courses of flooring. In every respect the structure should be stormproof and, as a safeguard, cement should never be piled in contact with the building walls. Cement that has become wet in storage is worthless.

When cement is stored for considerable periods, that in the sacks at the bottom of high piles is likely to become caked or take on what is often called a "warehouse set." If such cement has not been exposed to dampness, rolling or dropping the sacks on the floor will recondition it. Any lumps, however, which cannot be readily crushed by hand are an indication that moisture has affected the cement, and such lumps should be discarded.

When the Big Guns Roar

nearby cement construction is called upon to stand unusual concussion and strain. The stone, sand and cement must be of unquestioned quality.

In building the fortifications at Egmont and Mullet's Keys, Forts Hancock, Wadsworth, Slocum, Monroe, Strong, Mott, Totten and Schuyler and in making cement improvements at the Brooklyn, Portsmouth, Boston, Norfolk, Charleston, and League Island Navy Yards, at West Point, Annapolis, and elsewhere the United States Government has used hundreds of thousands of barrels of ALPHA CEMENT.



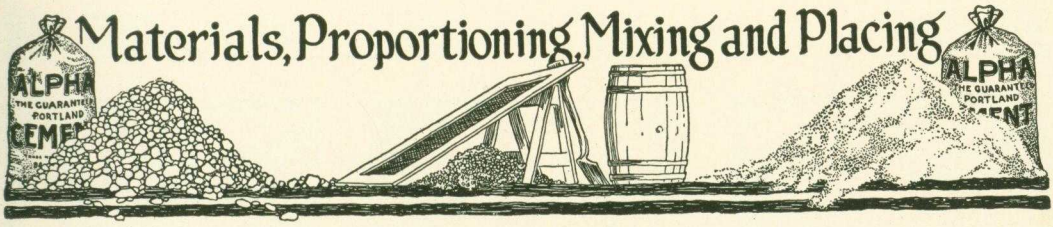
D. L. & W. R. R. Bridge

(Delaware River, Portland, Pa., just below the Water Gap.)

TREMENDOUS loads; speedy trains; swift currents; great masses of ice piling through the famous Delaware Water Gap; these are some of the conditions which had to be taken into account by the D. L. & W. R. R. engineers, who planned this extraordinary structure.

Today this magnificent bridge, containing more than 300,000 bags of ALPHA CEMENT, stands as an everlasting monument to American engineering skill and to the dependability of ALPHA CEMENT.

Materials, Proportioning, Mixing and Placing



GOOD cement is necessary to make good concrete. But Portland Cement no matter how good, can not make good concrete if mixed with sand, pebbles, broken stone or similar materials that are unsuitable.

ALPHA CEMENT meets the severest engineering and other specification requirements, thus relieving the user of further concern in that direction.

Most of the dissatisfaction experienced in the use of concrete can be traced to improperly graded sand, or sand containing loam or sand with clay-coated particles.

Test Your Sand. Sand that can be pulverized, that soils the hands, or that smells, will not make good concrete. To test sand, stir it in a glass of water. If it settles leaving the water clear with very little sediment, it is good. A heavy sediment is an indication that the sand is of doubtful quality. The best engineering practice is to reject sand if it contains more than 5 per cent of loam.

Colorimetric Test. Visual examination may be sufficient to disclose a sand of such distinctly unsuitable quality as to indicate its rejection. However, frequently the quantity of organic matter or other objectional impurity present is so small that it cannot be thus detected yet the sand in question is unfit for use in concrete or mortar. A simple test for the presence of organic matter is known as the "Colorimetric Test." This was developed as the result of studies by the Structural Materials Research Laboratory, Chicago. It can be made with sufficient accuracy for all ordinary purposes as follows:

"Obtain a 12-ounce graduated prescription bottle from any drug store and fill to the 4½-ounce mark with the sand to be tested. Add to this a 3 per cent solution of caustic soda, also obtainable at any drug store, until the volume of sand and solution after shaking amounts to 7 ounces. Let this stand for twenty-four hours. At the end of this time observe the color of the liquid above the sand. If the solution is colorless or nearly so—that is, has but a pale yellowish color, the sand may be considered sufficiently free from organic impurities for any use. On the other hand, if the solution is brownish yellow in color, or darker than a pale straw color, the sand should not be used in important cement work such as that required in roads and pavements or reinforced cement building construction. If, in general, the color is brownish throughout, the sand should not be used in anything but unimportant work such as footings or foundations that are not to carry heavy loads. If the solution is dark brown in color the sand should be rejected, no matter what the type of work."

This test furnishes a simple and inexpensive method of detecting the presence of such organic impurities as humus. The test is being used by a large number of testing laboratories, engineers and contractors in passing on the suitability of sand for use in cement work.

Coarse Sand Needed. Where strength and wearing qualities are demanded of cement work, the sand to be used should contain an excess of coarse particles. Fine sand is necessary in a mixture only in the grading of the whole bulk of sand, to reduce the volume of air spaces or voids in the mass. To be well adapted for cement work, the greater part of the sand should remain on a 50-mesh sieve—a sieve containing 50 linear divisions to the inch or 2500 holes to the square inch. Not more than 6 per cent should go through a 100-mesh sieve. All particles passing ¼ inch mesh are regarded as sand in such work. Small particles of clean stone from rock crushers, known as "screenings," if from hard durable rock, answer very well as sand. River sand averages well because usually the mud has been washed out of it. In cement construction, sand or materials used in its stead are known as "fine aggregate." Pebbles, broken stone or similar materials over ¼ inch used in cement work are known as "coarse aggregate."

Coarse Aggregate. Usually the maxi-

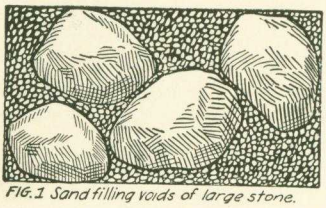


FIG. 1 Sand filling voids of large stone.

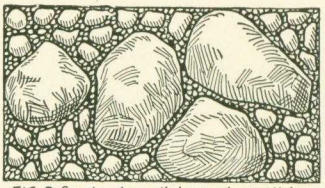


FIG. 2 Sand and small stone mixed with large.

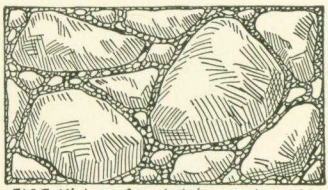


FIG. 3 Mixture of graded stone and sand.

mum size of aggregate, that is, pebbles or broken stone, is 1¼ or 1½ inches in diameter for most cement work. Some work such as cement block, cement fence posts, require a smaller maximum size; ¾ inch, for instance, is the usual maximum in fence-post manufacture, while the maximum of 1½ inches may at times be exceeded where the work is particularly massive, such as in some foundations. In very thick walls, dams, etc., large stone can be safely used provided it is clean and so placed as to be entirely surrounded by the cement and sand mixture.

No pebbles, broken stone or otner similar aggregate should exceed in greater dimension, half the thickness of the section in which they are used.

Trap Rock, Granites, Gravel. Like sand, pebbles or broken stone must be free from loam, clay or similar matter. They must be hard. Cement construction cannot be stronger than the materials of which it is composed. Hard granites, trap rock, hard pebbles from some gravel deposits, and slag, usually make the strongest concrete, provided the sand also has been selected with a view to uniform grading from fine to coarse and is composed of hard particles. Shale, slate, soft limestone and any material that crumbles, slivers or peels off, should be avoided. Having both the sand and the coarse aggregate of different sizes— so that the smaller particles will fit in between the larger—will reduce voids or air spaces in concrete. See the illustration at top of this page. Elimination of voids in this way, provided the correct amount of cement is used, accomplishes water-tightness, resulting in denser, and therefore stronger cement construction.

Use of Bank-Run Gravel. Natural deposits of combined sand and pebbles almost invariably contain a large excess of sand and it is true economy, as well as the best practice, to screen bank-run material and reproportion the sand and pebbles correctly.

In most gravel banks the quantity of sand—particles ranging from fine to ¼ inch size—is twice that of the pebbles, while for good concrete the proportions **should be about the reverse.** For instance, in a 1:2:4 mixture (see page 12), in which the particles of sand and pebbles are uniformly graded, voids or air spaces between the particles are reduced to such an extent that the sack of cement when added will practically fill these voids and hence produce the greatest possible density; that is, the 4 cubic feet of pebbles, well graded from ¼ inch to about 1½ inches, contain air spaces which the well graded 2 cubic feet of sand will fill, while the air spaces in the combined sand and pebbles will be filled by the cement. In fact, these proportions are such as to make a slight excess over and above that required for reducing the voids, and the concrete resulting from combining the 1 sack of cement, 2 cubic feet of sand and 4 cubic feet of pebbles will measure about 4.5 cubic feet in volume. This shows how the cement and sand have disappeared, so to speak, among the air spaces or voids in the bulk of pebbles.

If, as is often done, 6 cubic feet of material just as it comes from the gravel bank are used instead of the 2 cubic feet of sand and 4 cubic feet of pebbles, it can readily be seen that we start off in the first instance with a bulk of 6 cubic feet of material and the 1 sack of cement used would be entirely taken up in the air spaces, leaving a bulk of 6 cubic feet containing 1 sack of cement. Compare this with the other method, where the 4.5 cubic feet of concrete also contains 1 sack of cement. It requires but little thought to realize that the latter mixture must be denser and stronger on account of the greater relative proportion of cement contained.

Cinders as Aggregate. Cinders are used to some extent as a substitute for crushed stone or gravel. They are lighter and more porous than stone and less strong, but where lightness is more important than strength or where a poor conductor of heat or sound is required, they may be used. Successive floors of tall buildings are often laid with cinder concrete. Roofs are also constructed with it. Cinder concrete may be cut more easily than concrete made of stone; nails may be driven into it. The cinder used for cement work should not contain much, if any, fine ashes. Wood ashes should not be used at all. The cinders from power plants are better than ashes from household furnaces because the intense heat of the former fuses most of the ash into hard material, leaving little or no fine matter. Where the cinders have been drenched with water as soon as drawn from the furnace, they are still better, for the reason that the fine material is washed out. Cinders are easily crushed, and it is better practice not to ram concrete in which they are used, because the breaking up of the aggregate means increasing the surface to be covered by the cement. Both slag and cinders absorb more water than pebbles or crushed stone and therefore require more wetting. As cinders have been subjected to intense heat, the material is good from a fireproof point of view.

Slag. Blast furnace slag which has been properly air-cooled and aged is suitable aggregate for cement work. Copper, lead, or basic open-hearth slag should not be used; such materials are usually very brittle, have a glassy surface and readily cause disintegration. Slag that shows any signs of granulation has come into contact with water while hot and partial disintegration has taken place. Only slag that has been slowly cooled should be used. As there is considerable variation in the quality of slag, this material should be used with care. The best grade of slag is regarded by some engineers and builders as giving greater crushing strength to concrete than any other form of aggregate. Slag is particularly well adapted for concrete where light weight and fire-resisting qualities are desirable, as in floors, roofs, etc.

Porportioning. Concrete is usually proportioned by volume. For extreme precision and economy on large work, it is advisable to proportion mixtures under the guidance of laboratory tests, which are made to determine the exact percentage of voids of air spaces in the volumes of sand and pebbles or broken stone used. But on most cement work, experiments and tests have proven the following arbitrary mixtures suitable to the classes of work here designated.

Such figures as 1:2:3 indicate one part of cement—volume, not weight—to two parts of sand and three parts of the coarser aggregate.

Table of Recommended Mixtures and Maximum Aggregate Sizes

MIXTURE AND CHARACTER OF WORK	Recommended Maximum Size of Aggregate in Inches
1:1:1 Mixture for	
The wearing course of two-course floors subject to heavy trucking, such as occurs in factories, warehouses, on loading platforms, etc	½
1:2:3 Mixture for	
Reinforced cement roof slabs	1
One-course cement road, street, and alley pavements	3
One-course walks and barnyard pavements	1½
One-course cement floors	1½
Fence Posts	¾
Sills and lintels without mortar surface	¾
Watering troughs and tanks	1
Reinforced cement columns	1
Mine timbers	¾
Construction subjected to water pressure, such as reservoirs, swimming pools, storage-tanks, cisterns, elevator pits, vats, etc	1
1:2½:4 Mixture for	
Silo walls, grain bins, coal bins, elevators and similar structures	1½
Building walls above foundation, when stucco finish will not be applied	1½
Walls of pits or basements, exposed to moisture	1½
Manure pits	1½
Dipping vats, hog wallows	1
Backing of cement block	¾
Base of two-course road, street and alley pavements	3
1:2½:5 Mixture for	
Walls above ground which are to have stucco finish	1½

ALPHA CEMENT — HOW TO USE IT

MIXTURE AND CHARACTER OF WORK	Recommended Maximum Size of Aggregate in Inches
Base of two-course walks, feeding floors	1½
Bridge abutments and wing walls, culverts, dams, small retaining walls, when not reinforced	2
Basement walls and foundations where water-tightness is not essential	2
Foundations for small engines	2
1:3:6 Mixture for Mass concrete—large retaining walls, heavy foundations and footings	3
1:1½ Mixture for Inside finish of water tanks, silos, and bin walls, where required, and for facing walls below ground when necessary to afford additional protection against the entrance of moisture	To pass thru No. 8 Screen
Back plastering of gravity retaining walls	To pass thru No. 8 Screen

Mortars or Plastering Mixtures

1:2 Mixture for Facing block and similar cement products	¼
Wearing course of two-course walks, floors subjected only to light loads, barnyard pavements, etc	¼
1:2½ Mixture for Scratch coat of exterior plaster (cement and stucco)	To pass thru No. 8 Screen
Fence posts when coarse aggregate is not used	¼
1:3 Mixture for Intermediate and finish stucco coats	To pass thru No. 8 Screen
Cement block when coarse aggregate is not used	¼
Cement brick	¼
Cement drain tile and pipe when coarse aggregate is not used	¼
Ornamental cement products	¼

How to Figure Amounts of Materials

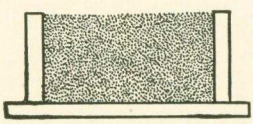
The first step in calculating quantities is, of course, to figure the total cubic space to be occupied by the concrete, which is learned by the simple method of reducing the dimensions to like units of measurement; for example, having all dimensions, feet or fractions of feet, and multiplying breadth and thickness together. For example, if a floor or driveway is to be 30 feet long by 12 feet wide and 6 inches thick, we have 30 by 12 by ½ equals 180 cubic feet, which divided by 27, the number of cubic feet to the yard, gives 6⅔ cubic yards of volume.

Figuring a Foundation. A foundation that is to be 1 foot thick, 10 feet high, 25 feet wide and 40 feet long would be figured as 1 by 10 by 23 equals 230 for the short wall and 1 by 10 by 40 equals 400 for the long wall. The reason for using 23 as the building length of the short wall is that if the long wall is figured the full length, its thickness will of course lessen the length of the short wall one foot at each end. As there are two short walls and two long ones, the totals of 230 and 400 would be double, giving 1260 cubic feet, from which should be deducted space occupied by doors and windows.

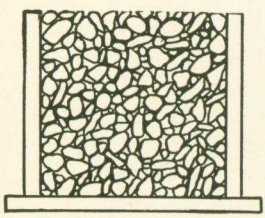
Amounts of Cement, Sand and Stone. In thoroughly mixed batches of concrete about 100 cubic yards of stone will be required for a job that has a cubic volume of 100 yards. Voids vary somewhat, but usually voids in crushed stone will average about 45 per cent and the voids in gravel about 40 per cent.

The simplest rule for mixing a batch of concrete is to take the proportions as a table of cubic feet. Thus, if the proportion is 1:2:4, use four cubic feet of stone, two of

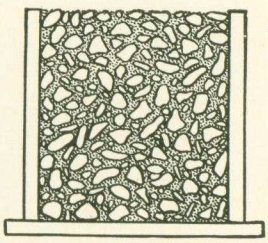
1 bag of CEMENT (about 1 cu. foot)



2 cu. feet of SAND



4 cu. feet of STONE



Slightly over 4 cu. feet of CONCRETE

Illustration of a 1:2:4 mix. Note that as the sand merely fills the voids of the stone and the cement fills the voids of sand, the seven cubic feet of material make a batch of only a little over 4 cubic feet of concrete. Beginners in cement construction ofter err in thinking that the volume of the concrete will equal the total volume of materials used

sand and one of cement. As most proportions used in cement work call for a quantity of sand that is 50 per cent, or a little more than 50 per cent of the bulk of the stone, the quantity of sand will slightly exceed the 40 or 45 per cent of voids and thus the mix for a cubic yard of cement will overrun a yard. In proportioning by volume, a sack of cement is considered as one cubic foot, and by weight, a sack of cement may be accepted as 94 pounds net.

Table 1 will be found very useful in calculating the quantities of sand and gravel, or stone, required for a one-bag batch of mortar or concrete, and in computing the volume of the resulting mortar or concrete.

It will be observed from Table 1, that the volume of finished concrete will overrun slightly when the rule is followed of using the same number of cubic yards of stone as there are cubic yards of volume in the job to be undertaken. Thus, when five yards of stone are used in a 1:2½:5 mixture the table gives the result of 5.4 yards of finished concrete. This difference comes mainly because the amount of sand used is slightly in excess of actual voids.

Example of Use of Table 1. If 100 cubic yards or 2700 cubic feet of space are to be filled with a 1:2½:5 mixture, 2700 should be divided by 5.4 in order to get the multiple of 500. 500 by 1 equals 500, which is the number of cubic feet or bags of cement to be used. 500 by 2½ equals 1250, which is the number of cubic feet of sand to be used and 500 by 5 equals 2500, amount of stone actually needed, no overrun being provided for.

Quantities by Weight for Differently Proportioned Concretes. The common practice is to sell sand and stone by the ton, and Table 2 gives the quantities of cement, sand, and stone required for concrete of different proportions. This is a more accurate table than No. 1, as quantities are given by weight instead of volume. Weights are given per cubic yard with the corresponding weights per cubic foot. The table is based on 45 per cent voids in the coarse aggregate.

TABLE 1

Mixtures			Materials			Vol. in Cu. Ft.	
Cement	Sand	Gravel or Stone	Cement in Sacks	Sand Cu. Ft.	Gravel or Stone Cu. Ft.	Mortar	Concrete
1	1.5	..	1	1.5	..	1.75	...
1	2.0	..	1	2.0	..	2.1	...
1	2.5	..	1	2.5	..	2.5	..
1	3.0	..	1	3.0	..	2.8	...
1	1.5	3	1	1.5	3	...	3.5
1	2.0	3	1	2.0	3	...	3.9
1	2.0	4	1	2.0	4	...	4.5
1	2.5	4	1	2.5	4	...	4.8
1	2.5	5	1	2.5	5	...	5.4
1	3.0	5	1	3.0	5	...	5.8

TABLE 2

MATERIALS REQUIRED FOR ONE CUBIC YARD OF CEMENT WORK

Cement by Bag; Sand and Stone by Ton of 2000 Pounds

Proportions				Sand of Various Weights				Stone of Various Weights										
Cement	Sand	Stone	Cement	Cu. Yd. 2400 Lbs. Cu. Ft. 88.9 Lbs.	Cu. Yd. 2500 Lbs. Cu. Ft. 92.6 Lbs.	Cu. Yd. 2600 Lbs. Cu. Ft. 96.3 Lbs.	Cu. Yd. 2700 Lbs. Cu. Ft. 100 Lbs.	Cu. Yd. 2000 Lbs. Cu. Ft. 74.1 Lbs.	Cu. Yd. 2100 Lbs. Cu. Ft. 77.7 Lbs.	Cu. Yd. 2200 Lbs. Cu. Ft. 81.5 Lbs.	Cu. Yd. 2300 Lbs. Cu. Ft. 85.2 Lbs.	Cu. Yd. 2400 Lbs. Cu. Ft. 88.9 Lbs.	Cu. Yd. 2500 Lbs. Cu. Ft. 92.6 Lbs.	Cu. Yd. 2600 Lbs. Cu. Ft. 96.3 Lbs.	Cu. Yd. 2700 Lbs. Cu. Ft. 100 Lbs.	Cu. Yd. 2800 Lbs. Cu. Ft. 103.7 Lbs.	Cu. Yd. 2900 Lbs. Cu. Ft. 107.4 Lbs.	Cu. Yd. 3000 Lbs. Cu. Ft. 111.1 Lbs.
1	1½	3	Bags	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons
1	1½	3	7.64	.504	.525	.546	.567	.850	.892	.935	.977	1.020	1.062	1.105	1.147	1.190	1.232	1.275
1	2	3	6.96	.624	.650	.676	.702	.770	.808	.847	.885	.924	.962	1.001	1.039	1.078	1.116	1.155
1	2	4	6.04	.540	.562	.585	.607	.890	.934	.979	1.023	1.068	1.112	1.157	1.201	1.246	1.290	1.335
1	2½	4	5.56	.612	.637	.663	.688	.820	.861	.902	.943	.984	1.025	1.066	1.107	1.148	1.189	1.230
1	2	5	5.32	.468	.487	.507	.526	.980	1.029	1.078	1.127	1.176	1.225	1.274	1.323	1.372	1.421	1.470
1	2½	5	4.96	.552	.575	.598	.621	.920	.966	1.012	1.058	1.104	1.150	1.196	1.242	1.288	1.334	1.380
1	3	5	4.64	.624	.650	.676	.702	.860	.903	.946	.989	1.032	1.075	1.118	1.161	1.204	1.247	1.290
1	3	6	4.24	.564	.587	.611	.634	.940	.987	1.034	1.081	1.128	1.175	1.222	1.269	1.316	1.363	1.410

Additional Useful Tables

TABLE 3

COMPRESSIVE STRENGTH OF CEMENT WORK

Strengths that may be expected from concrete made from ALPHA Portland Cement and first-class sand and coarse aggregate. Figures apply to concrete that has been well mixed and cured without drying out.

Mix by Volume	Average Compressive Strength of 6 by 12-inch Cylinders (1 lb. per sq. in.) at ages of			
	1 mo.	3 mo.	6 mo.	1 year
1:3:6	1200	1700	2000	2400
1:2½:5	1600	2200	2600	3000
1:2:4	2100	2700	3100	3500
1:2:3	2200	2900	3300	3700
1:1½:3	2600	3300	3700	4100

TABLE 6

CEMENT FOUNDATIONS—WALLS, ETC.

1 Cu. Ft. Concrete	Sacks of Cement	1 Cu. Yd. Concrete	Bbl. of Cement
1:1:1	.5404	1:1:1	3.375
1:1½:3	.2808	1:1½:3	1.895
1:2:4	.2220	1:2:4	1.498
1:2½:5	.1848	1:2½:5	1.247
1:3:6	.1570	1:3:6	1.060

TABLE 4

QUANTITIES OF MATERIALS REQUIRED FOR LINEAR FOOT OF CEMENT PAVING FOR THE WIDTHS AND THICKNESSES AT SIDES AND CENTER AS SHOWN

Width (feet)	Thickness Side and Center (inches)	CEMENT (bbl.)		SAND (cu. yd.)		Rock or Pebbles (cu. yd.)	
		1:2:3	1:1½:3	1:2:3	1:1½:3	1:2:3	1:1½:3
9	6–7	0.32	0.35	0.10	0.08	0.14	0.16
16	6–8	0.63	0.68	0.19	0.15	0.28	0.30
18	6–8	0.71	0.77	0.21	0.17	0.32	0.34
20	6–8½	0.82	0.90	0.24	0.20	0.36	0.40
24	6–9	1.01	1.10	0.30	0.24	0.45	0.49

Quantities based on the assumption of 45% voids in the coarse aggregate.

TABLE 5

NUMBER OF SQUARE FEET OF WALL SURFACE COVERED PER SACK OF CEMENT, FOR DIFFERENT PROPORTIONS AND VARYING THICKNESS OF STUCCO-PLASTERING

Materials				Total Thickness of Plaster				
Proportions of Mixture	Sacks Cement	Cu. Ft. Sand	Bushels Hair*	½ in. Sq. Ft. Covered	¾ in. Sq. Ft. Covered	1 in. Sq. Ft. Covered	1¼ Sq. Ft. Covered	1½ in. Sq. Ft. Covered
1:1	1	1	⅛	33.0	22.0	16.5	13.2	11.0
1:1½	1	1½	⅛	42.0	28.0	21.0	16.0	14.0
1:2	1	2	⅛	50.4	33.6	25.2	20.1	16.8
1:2½	1	2½	⅛	59.4	39.6	29.7	23.7	19.8
1:3	1	3	⅛	67.8	45.2	33.9	27.1	21.6

*Used in scratch coat only.

NOTE. These figures are based on average conditions and may vary 10 per cent either way, according to the quality of the sand used. No allowance is made for waste.

TABLE 7

MATERIALS REQUIRED FOR 100 SQ. FT. OF SURFACE FOR VARYING THICKNESS OF PLASTER

Proportions	1:1		1:2		1:2½		1:3	
Thickness (in.)	Cement (sacks)	Sand (cu. yd.)	Cement (sacks)	Sand (cu. yd.)	Cement (sacks)	Sand (cu. yd.)	Cement (sacks)	Sand (cu. yd.)
⅜	2.2	0.08	1.5	0.11	1.3	0.12	1.1	0.13
½	3.0	0.11	2.0	0.15	1.7	0.16	1.5	0.17
¾	4.5	0.16	2.9	0.22	2.5	0.23	2.2	0.25
1	6.0	0.22	3.9	0.29	3.3	0.31	3.0	0.33
1¼	7.5	0.27	4.9	0.36	4.2	0.39	3.7	0.41
1½	9.0	0.33	5.9	0.43	5.1	0.47	4.5	0.50
1¾	10.5	0.39	6.9	0.50	6.0	0.56	5.4	0.60
2	12.0	0.45	7.9	0.58	6.9	0.64	6.2	0.69

If hydrated lime is used it should be added in amounts of from 5 to 10% by weight of the cement.
Hair is used in the scratch coat only in amounts of ⅛ bushel to 1 sack of cement.
These figures may vary 10% in either direction due to the character of the sand.
No allowance is made for waste.

TABLE 8

MATERIALS REQUIRED FOR 100 SQ. FT. OF SURFACE FOR VARYING THICKNESS OF COURSE

Thickness	1 in.			2 in.			4 in.			5 in.		
Mix	Cement	Sand	Stone	Cement	Sand	Stone	Cement	Sand	Stone	Cement	Sand	Stone
1:2	3.9	0.29	.....	7.9	0.58	.....	.....	.....	.....	.....	.....	.....
1:1:1	4.2	0.15	0.15	8.3	0.31	0.31	.....	.....	.....	.....	.....	.....
1:1:1½	3.7	0.14	0.20	7.3	0.27	0.41	.....	.....	.....	.....	.....	.....
1:1½:2½	2.6	0.14	0.24	5.1	0.28	0.47	.....	.....	.....	.....	.....	.....
1:1½:3	.....	.....	.....	.....	.....	.....	9.4	0.52	1.04	11.7	0.65	1.30
1:2:3	.....	.....	.....	.....	.....	.....	8.6	0.64	0.95	10.8	0.80	1.19
1:2:4	.....	.....	.....	.....	.....	.....	7.4	0.55	1.10	9.3	0.69	1.37
1:2½:4	.....	.....	.....	.....	.....	.....	6.9	0.64	1.02	8.6	0.80	1.27
1:2½:5	.....	.....	.....	.....	.....	.....	6.2	0.57	1.14	7.7	0.72	1.43
1:3:6	.....	.....	.....	.....	.....	.....	5.2	0.58	1.16	6.5	0.73	1.45

Thickness	6 in.			7 in.			8 in.			9 in.		
Mix	Cement	Sand	Stone	Cement	Sand	Stone	Cement	Sand	Stone	Cement	Sand	Stone
1:1½:3	14.0	0.78	1.56	16.4	0.91	1.82	18.7	1.04	2.08	21.1	1.17	2.34
1:2:3	12.9	0.95	1.43	15.0	1.11	1.67	17.2	1.27	1.90	19.3	1.43	2.14
1:2:4	11.1	0.82	1.64	12.9	0.96	1.92	14.8	1.10	2.19	16.7	1.23	2.47
1:2½:4	10.3	0.95	1.53	12.0	1.11	1.78	13.8	1.27	2.03	15.5	1.43	2.29
1:2½:5	9.2	0.86	1.72	10.8	1.00	2.00	12.3	1.14	2.29	13.9	1.29	2.57
1:3:6	7.9	0.87	1.74	9.2	1.02	2.03	10.5	1.16	2.32	11.8	1.31	2.61

NOTE. Quantities expressed in the following units:
Cement...sacks; Sand...cubic yards; Pebbles or Broken Stone...cubic yards.

TABLE 9

MATERIALS REQUIRED FOR 100 SQ. FT. OF SIDEWALKS AND FLOORS FOR VARYING THICKNESS OF COURSE

CEMENT BASE

Proportions	1:2:3			1:2:4			1:2½:4			1:2½:5		
Thickness	Cement	Sand	Stone	Cement	Sand	Stone	Cement	Sand	Stone	Cement	Sand	Stone
2½	5.4	0.40	0.60	4.6	0.34	0.68	4.3	0.40	0.63	3.9	0.36	0.72
3	6.5	0.48	0.72	5.6	0.41	0.82	5.2	0.48	0.77	4.6	0.43	0.86
3½	7.5	0.56	0.84	6.5	0.48	0.96	6.0	0.56	0.89	5.4	0.50	1.00
4	8.6	0.64	0.95	7.4	0.55	1.10	6.9	0.64	1.02	6.2	0.57	1.14
4½	9.7	0.72	1.07	8.3	0.62	1.23	7.7	0.72	1.14	6.9	0.64	1.28
5	10.8	0.80	1.19	9.3	0.69	1.37	8.6	0.80	1.27	7.7	0.71	1.43
5½	11.8	0.88	1.31	10.2	0.76	1.50	9.5	0.87	1.40	8.5	0.78	1.57
6	12.9	0.96	1.43	11.1	0.82	1.64	10.3	0.95	1.53	9.2	0.86	1.72

WEARING COURSE

Thickness	1:1		1:1½		1:2	
Inches	Cement	Sand	Cement	Sand	Cement	Sand
½	3.0	0.11	2.4	0.13	2.0	0.15
¾	4.5	0.16	3.6	0.19	2.9	0.22
1	6.0	0.22	4.8	0.26	3.9	0.29
1¼	7.5	0.27	6.0	0.33	4.9	0.36
1½	9.0	0.33	7.2	0.40	5.9	0.43
1¾	10.5	0.39	8.4	0.46	6.9	0.50
2	12.0	0.45	9.6	0.53	7.9	0.58

NOTE. Quantities expressed in the following units:
Cement—sacks;
Sand—cubic yards;
Pebbles or Broken Stone—cubic yards.

Mixing

Proper mixing of materials, with the right amount of water, determines very largely the strength and watertightness of concrete. Too often concrete is mixed with less or with more water than is necessary.

Such terms as "wet," "soupy," "medium," "quaky" and "dry," while not always accurate in their description of consistency of a mixture, are nevertheless in general use. They describe in the order here named, the variations from wet to dry.

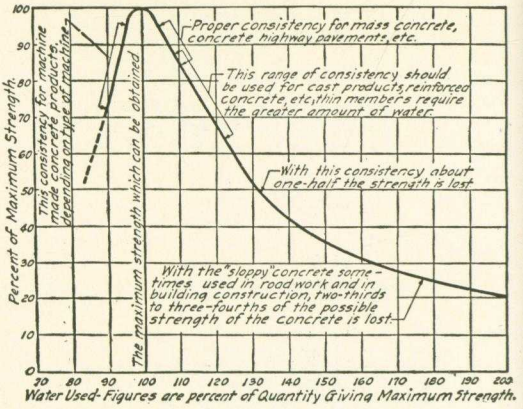
Quaky Mix. This consistency—jelly-like—is preferred in a mixture for nearly all classes of general construction. Such a mixture will, when heaped into a pile gradually flatten of its own weight, yet at no time in handling it will there be a separation between the sand-cement mortar and the pebbles or broken stone. Too much water in such a mixture would cause a separation of materials, forming pebble pockets or porous spots, resulting in a concrete of variable density when placed. Too little water, on the other hand, would prevent complete "hydration" of the cement and cause a weakened concrete mixture. "Hydration" means the chemical changes which take place in cement resulting in complete hardening. The quaky or jelly-like consistency contains about the correct amount of water to accomplish this result. Forms surrounding earth—as in the case of foundations—absorb some of the water and this should be taken into account.

Wetter Mixes. There are, however, several conditions under which one must use mixtures containing more or containing less water than described by the word "quaky." For instance, in some reinforced cement work where the wall or section being placed is thin, it is necessary to use slightly more water so that the concrete can be well puddled around the reinforcing metal and thus be caused to adhere or bond it firmly.

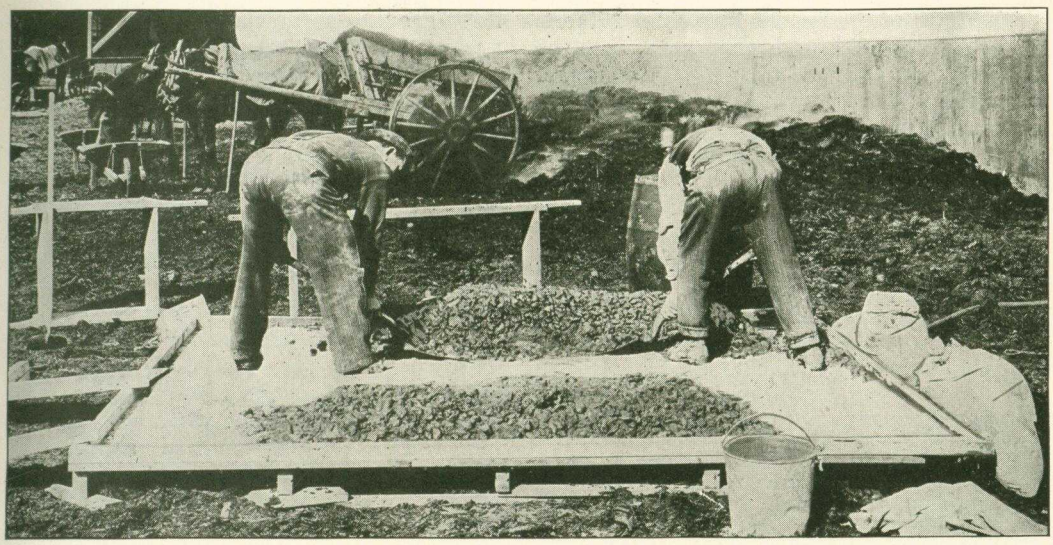
Drier Mixes. Cement block made in certain types of machines, and cement drain pipe or tile, are good examples of cases where mixtures should contain less water than the "quaky" consistency.

In the case of drain tile and pipe, the mixtures used should contain enough water so that when the molds are removed from the product or vice versa, distinct water markings will show on the surface of the tile, thus indicating that the revolving core or packer head of the machine has been working in a mixture wet enough to cause free moisture to flush to the surface. Such a mixture can be used in any of the modern block machines.

Only recently have studies been completed showing the important part which the quantity of mixing water used bears to the strength of the resulting cement work. This is expressed in one way in the chart here shown but to make this chart clearer, the following example is given.


Percent of Maximum Strength.
100
90
80
70
60
50
40
30
20
10
0
Proper consistency for mass concrete, concrete highway pavements, etc.
This range of consistency should be used for cast products, reinforced concrete, etc, thin members require the greater amount of water.
With this consistency about one-half the strength is lost.
With the "sloppy" concrete sometimes used in road work and in building construction, two-thirds to three-fourths of the possible strength of the concrete is lost.
This consistency for machine made concrete products, depending on type of machine.
The maximum strength which can be obtained
70 80 90 100 110 120 130 140 150 160 170 180 190 200
Water Used- Figures are percent of Quantity Giving Maximum Strength.

The curve shows that if 20 per cent more water is used than required for maximum strength possible in a certain concrete mixture, the strength of concrete will be reduced by 30 per cent by the addition of such 20 per cent of water. If 30 per cent more water is used the possible strength of the concrete will be reduced by one-half. Not only does an excess of mixing water reduce strength and resistance to wear of floors and pavements, but it amounts practically to a waste of cement. If, for example, one pint more water is used than necessary in a one-sack batch of concrete, the resulting concrete is decreased in strength just as much as it would be if two or three pounds of cement were kept out of the mixture. In most types of construction it is difficult to properly work into place a concrete mixture having the exact water content that would result in a concrete of maximum strength. It is, therefore,



Care should be taken to see that the cement is mixed *thoroughly* with the sand and stone. This may be done by shoveling the materials back and forth, turning it over each time, until the mass has a uniform color and all the stone is coated with cement-mortar

necessary in practice to use a little more water than actually required. It must be remembered always, however, that the excess of water affects the strength. Therefore, any excess of water necessary must be kept to the lowest possible limit. Because sand and coarse aggregates may, for various reasons and under different conditions contain different quantities of moisture, it is not practicable to specify a fixed volume of water for each batch of concrete. However, minimum and maximum quantities that closely approximate requirements under average conditions can be set down. The accompanying table shows these quantities for a variety of concrete mixtures:

Mix		Approximate Mix as Usually Expressed			Water Required (Gallons per sack of cement)	
Cement	Volume of Aggregate after Mixing	Cement	Aggregate		Minimum	Maximum
			Fine	Coarse		
1	3	1	1¼	2½	5	5½
1	4	1	1½	3	5½	6
1	4½	1	2	3	5¾	6¼
1	5	1	2	4	6	6½
1	6½	1	2½	5	7¼	7¾
1	7¾	1	3	6	8¼	8¾

Finally, remember always to use the smallest quantity of mixing water that will produce a workable mix.

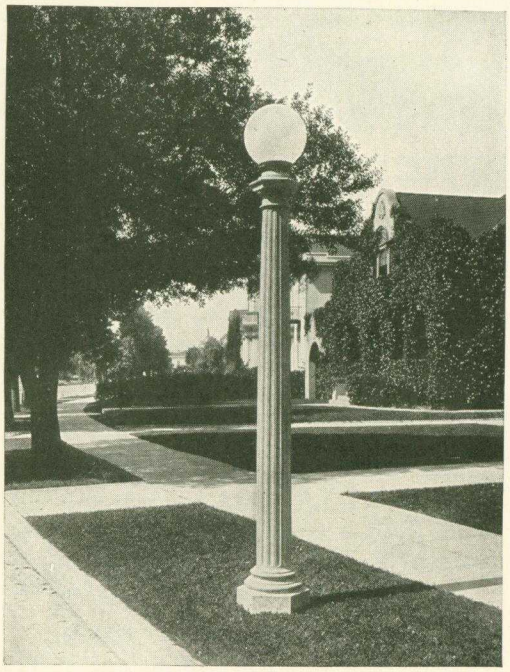
Water—Quality to Use. The simplest specification for mixing water is to say that it shall be good enough to drink. If this requirement is met, the water is suited for use in cement work.

Methods of Mixing

Good concrete can be made by hand mixing, but unless laborers are carefully watched and instructed as to the best way of turning materials, imperfectly mixed concrete is likely to result. Machine mixing is more dependable, especially in the batch type of mixer. These come in almost any desired capacity and are relatively low in cost. Many cement and building material dealers rent such mixers to their cement customers, and often farmers join in groups and buy power mixers that all of them can use.

Mixers of the batch type are preferable since measured materials must be put in the drum for each batch, while in the continuous type of mixers there is always possible some variation in moisture content or proportions of materials that may cause the concrete to lack uniformity.

Length of Time in Machine Mixers. Often concrete has been mixed for too short a period of time. Most mixer manufacturers recommend the number of revolutions per minute at which the drum of their machines should be revolved for best results. Whether mixed by hand or machine, mixing should continue until the mixture is of uniform color and consistency. Care should be taken when machine mixing not to revolve the mixer drum too rapidly, otherwise materials will cling to its surface and not be tumbled about, hence will be imperfectly mixed. As a general rule, no batch of concrete which is machine mixed should be removed from the drum until mixing has continued for at least one minute and in certain types of machines, 1¼ or 1½ minutes would be better.



Cement lamp standard combining beauty with permanence

Working Methods in Hand Mixing. For measuring materials a bottomless box or frame of 1 or 4 cubic feet capacity should be placed on a board, filled to the required level, and lifted off. Mixing by means of shovelfuls or wheelbarrow loads is uncertain. A frame that holds 4 cubic feet, should be marked on the inside at various levels to indicate 1, 2 and 3 cubic feet. Cement need not be measured in proportioning a mixture unless a batch requiring a smaller quantity than 1 sack is to be mixed, as 1 sack (94 pounds net) is, for convenience, considered 1 cubic foot in proportioning mixtures.

Few tools are needed for mixing and placing concrete. A platform 8 by 14 feet made of tongued and grooved 1½ or 2-inch stuff so that tight joints will result, is necessary for hand mixing. A strip nailed around the outer edges on three sides will prevent the loss of cement that might be carried away when adding mixing water. Square-pointed shovels are necessary for turning the materials on the board. A sprinkling can, or hose with nozzle, a water barrel, measuring box, wheelbarrows, tampers, spading tools, a wood float, screen, steel trowel and possibly a groover and edger, are about all the tools needed.

In mixing a one-bag batch by hand in the proportions of 1:2:4, first spread out the two cubic feet of sand on the board. Distribute one bag of cement over the sand as evenly as possible. Then with shovels, turn this material thoroughly, first dry and then wet, applying the water evenly. Now spread this mortar out and place the four cubic feet of stone on top. This mass should be turned repeatedly, with water being applied evenly. Note the illustration on page 17 which shows the usual method of turning with the shovels. The turning process must be kept up until the mass is thoroughly mixed. It is better to err in the direction of turning the material too often than to fail to mix well enough. Streaks of cement indicate that the mixing is not thorough. It is better to keep the pile of stone wet beforehand, so it will already have absorbed some water. The method here described is not the only way by which concrete can be mixed. In fact, any method by which the various materials will be thoroughly mixed is satisfactory, but this plan has the advantage that the stone—which is the heaviest material and costs the most to shovel—is not added until the cement and sand have been into a mortar. Where bank-run gravel has about the right proportions of sand and coarse material and is to be

used, spread that out on the mixing board and put the cement on top. Turn with the shovel several times dry, then sprinkle the material thoroughly and continue the turning process until the mass has been shoveled not less than four or five times. Shoveling the mixed materials into wheelbarrows will answer as one turning. A rake should not be used in mixing batches when the coarser material has been added as it draws the larger stone away from the smaller. Some use the rake to mix the cement with the sand.

All materials, tools, etc., should be placed near the mixing board, so as to reduce labor as much as possible.

Sand and cement should never be mixed long before the pebbles and water are added to complete the mixture, because all sand contains sufficient moisture to start a setting of the cement which would rob the concrete of some strength.

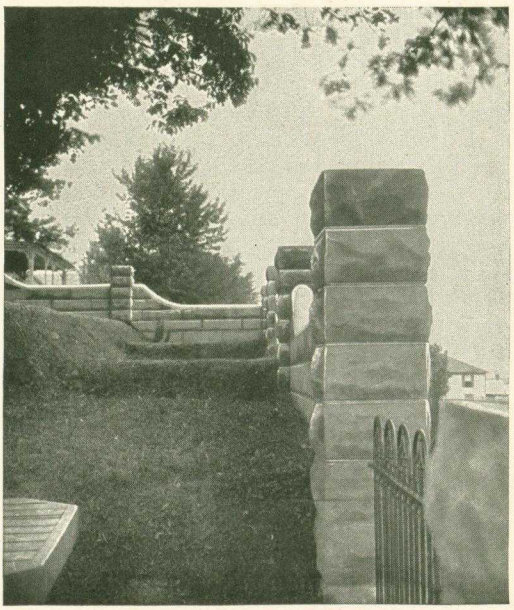
It is very necessary in mixing concrete that all of the particles of sand be thoroughly coated with a film of neat cement and water, and that the resulting mortar shall be sufficient to coat thoroughly the larger particles of broken stone so that the whole mass will be firmly bound together. Broken stone, especially some limestones, contain a great deal of fine dust. This prevents a good bond between the mortar and stone.

Placing the Concrete. Immediately after mixing the concrete should be placed. This suggests where possible to do so, the mixing platform, or the mixer, be located near the point where concrete is to be placed. This makes it convenient to shovel the concrete directly into forms.

Spading to Secure Density and Good Surface. Concrete batches are spaded into place rather than tamped. A convenient tool for spading is an old garden spade, or a hoe which has been straightened out so that the blade is in line with the handle. Special spading tools are also made with perforations in the blades which assist to bring the sand-cement mortar against form faces while holding back the coarse particles in the concrete and in this way produce a smooth surface finish when forms have been removed.

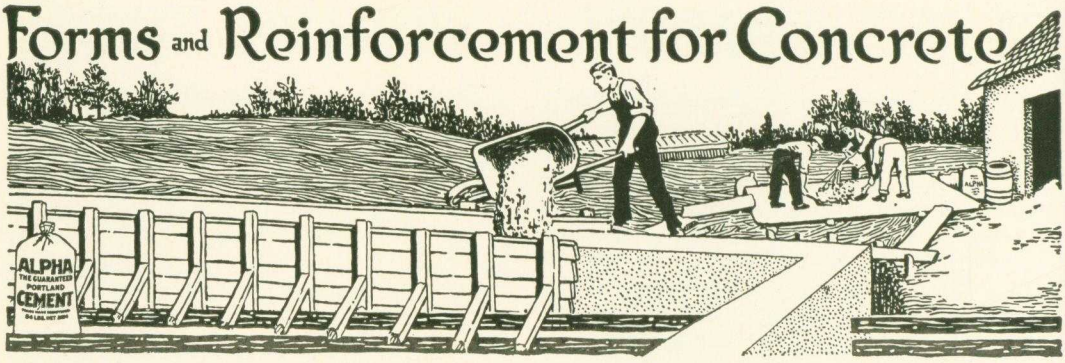
Protection of Fresh Construction

Regardless of how carefully the materials for any cement work may have been selected, proportioned, mixed and placed, the resulting success or failure must depend largely on whether or not the concrete is protected against too rapid drying out after it is placed. If suitable protection is not afforded, the concrete instead of hardening, simply dries out as a result of evaporation of a large portion of the mixing water. Cement construction which exposes a large surface area to sun and wind, such as walks, feeding floors, barnyard pavements, etc., must be protected against rapid drying out by a layer of some moisture-retaining material. Sand, sawdust, hay, straw, old canvas, burlap, carpets, or similar covering applied as soon as the concrete surface can be covered without marring it, accomplishes the purpose. Such coverings should be kept wet by frequent sprinkling for from a week to ten days or more, depending upon the nature of the work and the temperature conditions. Manure may be used for this purpose only if means are provided for preventing manure from coming into direct contact with the fresh concrete and spoiling its appearance.



Durable cement-block wall

Forms and Reinforcement for Concrete



IN order to use a concrete mixture, forms or molds are necessary so that the mass when hardened will have assumed the required shape and form. For a number of classes of cement construction and products, such, for instance, as sewers, silos, double monolithic building walls, cement block, brick and tile, there are various types of patented forms and machines which permit quite a range of adjustments to adapt them to various dimensions of structures or products for which they are designed. Such forms or molds are almost invariably made of metal, sheet steel being the material principally used.

By far the largest part of cement building construction is, however, done by using wooden forms; and as it is rare for any two structures to be of exactly the same dimensions and detail throughout, more or less special form work has to be done for each particular job. It is possible, however, to design wood forms as unit panels, somewhat like that shown in Fig. 1, having dimensions of 2 by 4 feet or 2 by 6 feet or more, so that the forms may be used repeatedly, at least on certain parts of any square or rectangular structure.

Wood forms are often lined with galvanized iron or sheet steel to make them more durable and to assist in producing a smooth surface on the finished work.

Various kinds of lumber may be used for form construction. When moldings or decorative trim is to be reproduced in concrete, white pine is desirable as it may be worked easily; but white pine is rather expensive, and being soft is not very durable. Hard woods are also expensive and difficult to work. Norway pine and spruce are probably used most for form work.

Contrary to the usual practice in building construction, green lumber or lumber which is only partly air-dried will keep its shape in concrete forms for rectangular construction better than lumber that is kiln-dried. If kiln-dried lumber is used it should be thoroughly wet before concrete is placed. This is because the lumber will absorb the water from the concrete, and if the forms are made tight, as they should be, the swelling from absorption will cause the forms to buckle or warp. Oiling or greasing the inside of forms before use is recommended, especially where forms are to be used repeatedly as it prevents absorption of water and also assists in keeping them in shape when not in use.

It is often possible to build forms from stock lengths of lumber, without cutting

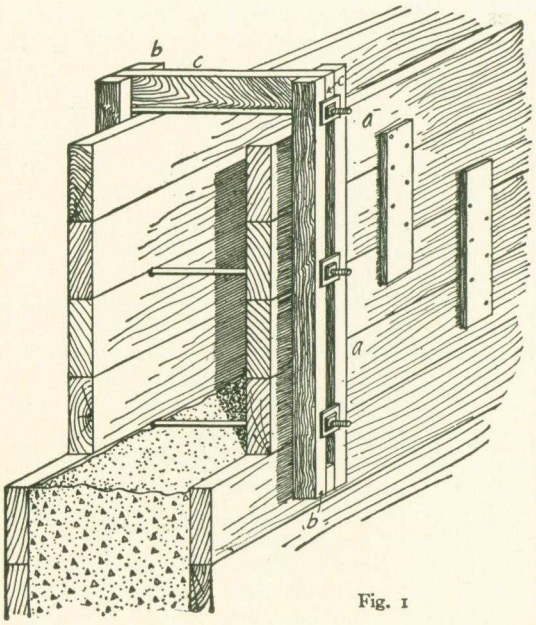


Fig. 1

and thereby wasting material. After use, forms so built may be carefully taken apart and the lumber can be put to other uses. A form for a column footing, for example, may sometimes be made as shown in Fig. 2 without cutting lumber.

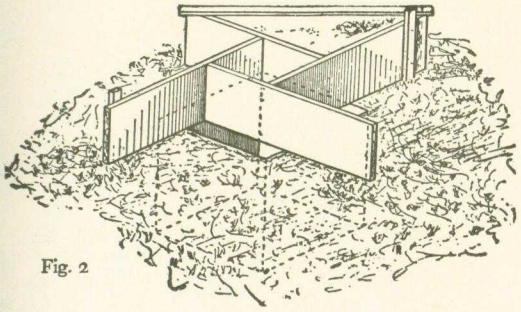


Fig. 2

Form lumber should be free from loose knots or other defects and irregularities that would be reproduced by the concrete. Lumber that is planed on both edges and one side is preferable, as it will give a smooth surface finish to the concrete. It is very essential that lumber for form work, where the concrete is to be exposed, be of uniform thickness, as when nailed to the studs any inequalities of thickness will result in an irregular surface on the concrete. As a rule, 1, 1½ and 2-inch lumber is most used. The added cost of dressed lumber is more than offset by the convenience in handling, working up and placing. Tongued-and-grooved lumber is often used for form sheathing, although what is known as shiplap is better. Lumber having slightly beveled edges is preferred by many because when it swells the edges will mash together enough to result in tight joints; this prevents water from leaking away and carrying cement with it.

Usually 2 by 4's, 2 by 6's, or in extreme cases 2 by 8's are used as form studs. The volume of concrete, or weight that must be supported determines the dimensions and spacing of form studs. Forms constructed of 2 by 4's with one-inch sheathing, should have studs spaced not more than two feet apart, in order to prevent any bulging of the sheathing when subjected to the ramming of placing concrete, and its outward pressure until hardened.

Forms must be braced thoroughly when set up, and then held the correct distance apart by spacers, these being removed just before the concrete reaches them. Bolts or wire ties may be used to hold forms against the spacers and from spreading apart. If bolts are used they may be greased before concrete is placed so they can be driven out of the concrete easily when forms are removed. It is best to break the bond of the concrete around such bolts within 24 hours. This may be done by merely tapping them with a hammer. Wire ties are generally used and are cut when taking down forms, all of the wire, except the projecting ends, being left in the concrete. Fig. 3 shows how the forms are tightened against spacers by twisting the wire ties.

When a cement foundation is not to enclose a cellar or basement, it will often be found that the soil is sufficiently self-sustaining to permit depositing concrete in the foundation trench without forms, as in Fig. 4. For all work above ground, however, forms are required; these may be of such a type as that illustrated in Figs. 6 and 7.*

As many foundations are provided with a footing, this may sometimes be constructed by omitting to nail sheathing boards on the lower eight or ten inches of the form studs as resting in the foundation trench, thus allowing the first concrete deposited to spread out and form the footing. See Figs. 6 and 7.

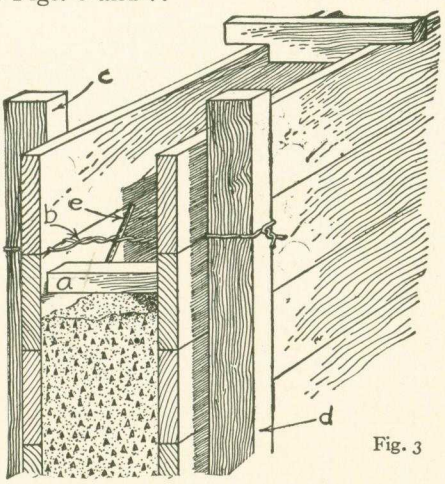


Fig. 3

*When the earth wall is sufficiently self-sustaining to permit dispensing with an outside form, only the single inner form section need be used except when the work has reached a point above ground, then, of course, two forms (inner and outer) will be required. For example, in Figs. 6 and 7 the form next to the earth wall could be omitted if the ground were firm.

As concrete weighs from 130 to 150 pounds per cubic foot, floor and roof forms particularly must be designed with a sufficient factor of safety to prevent them from sagging from their own weight as well as that of the concrete. Any sagging of forms will result in small cracks developing while the concrete is hardening, and these will gradually widen, preventing the construction from having the

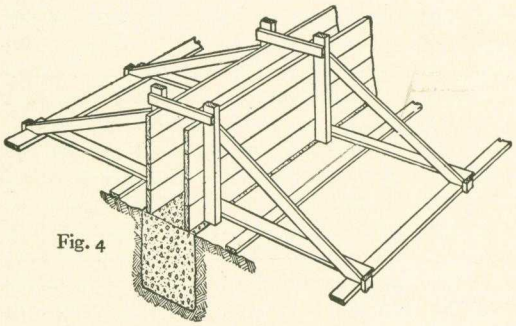


Fig. 4

desired strength. Enough braces, struts, and studs must be used to prevent forms from sagging. Various methods of bracing are shown in Fig. 5 and elsewhere.

Forms should be designed with every regard for economy of lumber, and when assembling them as few nails as possible should be used. In some cases screws and clamps used instead of nails will permit removing forms with the least hammering and least injury to the fresh concrete. No very wide boards should be used in form construction, from four to six inches being the preferred widths, with eight inches as the maximum. Wider boards are difficult to keep from warping and bulging.

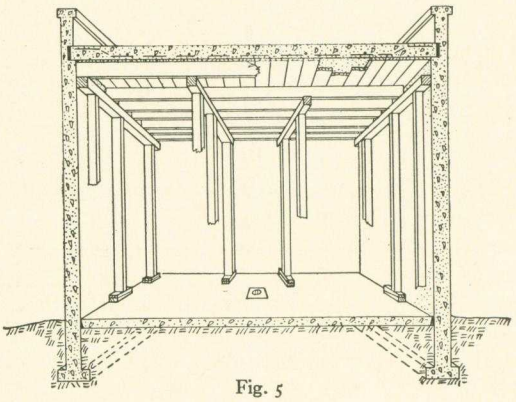


Fig. 5

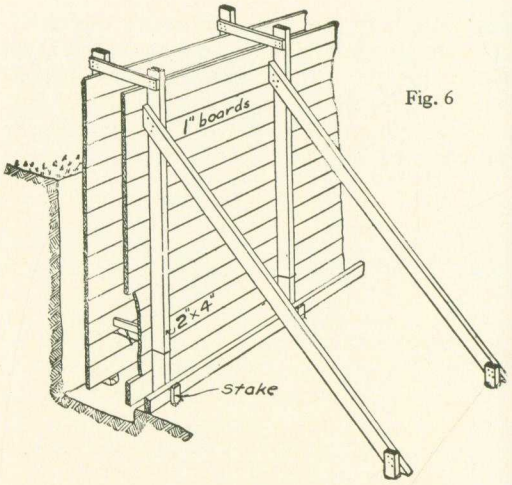


Fig. 6

Forms for floors laid on the ground and for walks, should consist of two-inch lumber having a width equal to the desired thickness of the floor or walk and should be staked in position. Very few nails if any are needed in forms for walks, feeding floors and similar pavements. Stakes well driven will hold form boards in proper position.

Straight walls and flat floors usually require the simplest types of forms. Corners, offsets, bends and various kinds of breaks or projections from the plain surface, such as in columns, beams, cornices and walls with openings and angles increase the cost.

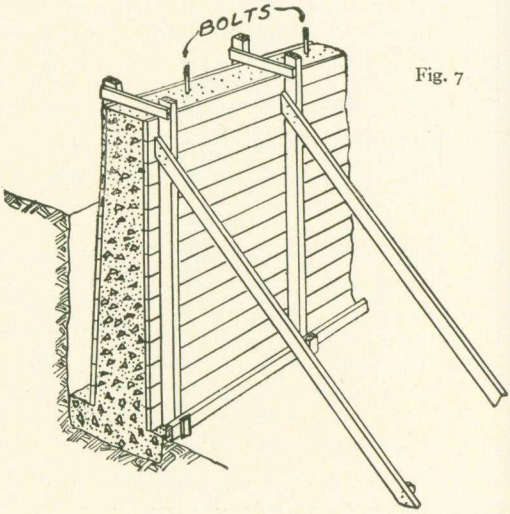


Fig. 7

With care in taking down forms it is possible to use lumber several times, so the longer it is in service the less the percentage of original cost to charge to any one job. For some classes of work form lumber can be used more than ten times.

Unit Forms. The greatest economy is gained by building forms so that they can

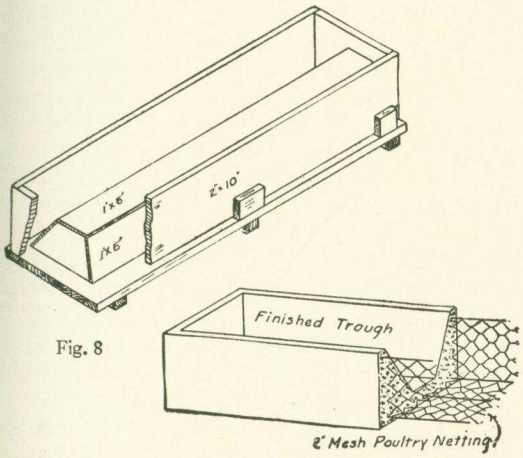


Fig. 8

be repeatedly used. Most people who have paid any attention to a contractor at work building the foundation of a small house, for example, have noticed that he brings to the work a set of standard form panels and sets them up by bracing or otherwise. Such panels represent a convenient form unit permitting most repetition in use. These units should be carefully handled and each time thoroughly cleaned when taken down preparatory to subsequent use. As indicated by the sketches on the blue-print insert between pages 24 and 25, but few standard panel sections are required. For example, the standard unit may be 2 by 4 feet. Supplemental sections may be 2 by 2 feet, 1 by 2 feet and 1 by 4 feet. A little experience in setting up such forms gained by using them once or twice, will indicate how many of the smaller sized panels may be profitably provided and kept on hand to permit closing up stretches of wall of different lengths. The principal precaution to take in making such panels is to see that the frame studs on which the sheathing is nailed or screwed are cut up and assembled with such precision that the bolt holes for bolts used in assembling sections shall exactly coincide no matter how the form panel may be turned, thus making it possible to set up forms true to line.

Miscellaneous Pointers on Forms and Their Use. Concrete will not stick to forms that are oiled each time before use with a mixture of boiled linseed oil and kerosene, equal parts of each, but if not so oiled they should at least be thoroughly wetted down. They should be carefully cleaned of all particles of adhering concrete after removal and be wet down immediately before again placing concrete in them.

Forms for the ordinary types of square or rectangular stock watering troughs, hog feeding troughs (Fig. 8), manure pits (Fig. 9), are all of a simple type, and when the earth is firm enough to be self-sustaining only an inside form will be necessary. Otherwise, form construction simply amounts to one frame within another; that is, two bottomless boxes of different sizes, one set inside of the other. Forms for square or rectangular tanks that are to be built above ground should provide for a batter or slope on the inside of the structure so that the expansion from freezing water will be spent upward instead of against the tank sides. Fig. 8 illustrates this. For such tanks as cisterns, which are usually placed wholly underground, of course a

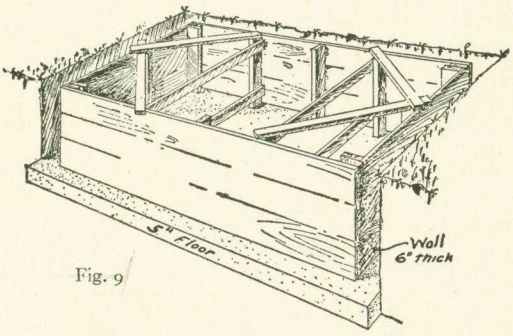


Fig. 9

Arrangements of forms for a manure pit

form is needed for the cement roof or cover slab. This is in the nature of a floor supported by studs.

There is no possibility of stating with precision the time when forms may safely be removed from any piece of construction. This varies entirely with weather conditions and the mass of concrete. Whenever the structure is one which need support no

weight but its own, such as a building wall of medium dimensions, all above ground, forms can sometimes be removed in three or four days. There is no advantage,

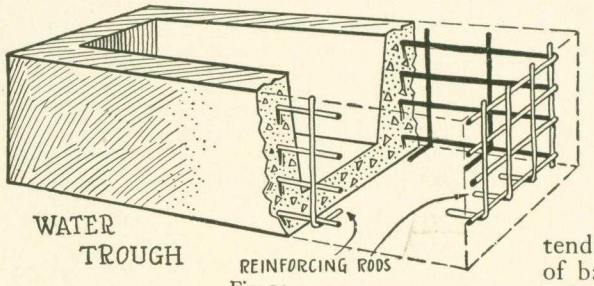


Fig. 10

however, in removing forms too early because the forms afford desirable protection to the concrete in preventing it from drying out too rapidly and also prevent a too rapid radiation of the chemical heat generated by the set of the cement. Forms for heavy arches, for floors supported above ground and roofs, must all be left in place from ten days to two, three or four weeks. It is a wise plan to leave forms in place a few days longer than may seem absolutely necessary, just to be on the safe side. Such a precaution often marks the difference between failure and success.

Reinforced Cement Construction
Materials to Use

"Reinforcing" is the name given to the practice of embedding steel in concrete, to increase its strength against tension, or forces that tend to pull it apart. Concrete, like many building stones, is strong in compression; that is, in bearing loads which are placed directly upon it, but is relatively weak in tension; that is, in resisting forces which tend to pull it apart.

The materials usually employed to reinforce concrete are steel rods of various forms, and woven mesh fabric similar to some of the common types of wire fencing. The reason for this is that specification requirements governing the practice of reinforcing concrete call for steel that possesses certain chemical and other qualities. Perhaps by far the commonest kind of reinforcing used is plain round or square or twisted square bars.

There are several types of so-called deformed bars to be had, many of which are patented, and therefore including in their price, royalty for the patentee. Deformed bars give a better mechanical bond between steel and concrete. However, in common types of construction, the other types of bars will answer when used with a quaky concrete mixture.

While it is possible to use old barbed wire and other waste materials to reinforce concrete, there are many difficulties and uncertainties attending their use. This is particularly true of barbed wire. The material is very difficult to place and to keep in proper place while depositing concrete, and unless reinforcing is placed and held in correct position while concrete is being deposited, a great deal of its possible effectiveness is lost.

If wires are to be substituted for the steel rods recommended, then one should be certain that the quantity of wires used equals in cross-sectional area the amount of rods for which substituted. The same holds true of using mesh fabric in place of rods. Mesh fabric is generally used instead of rods for floor, roof and pavement reinforcing.

On cement work that has been the

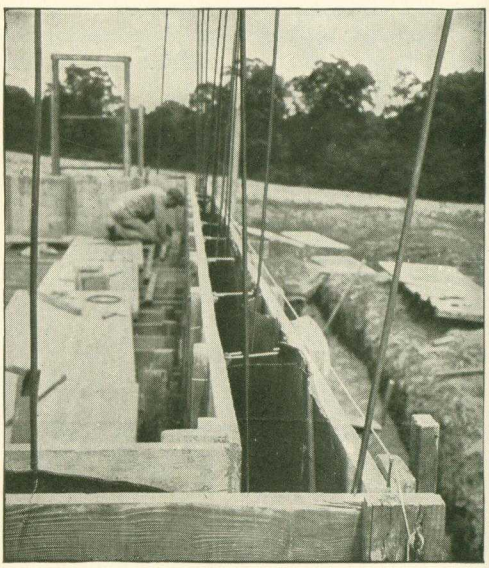
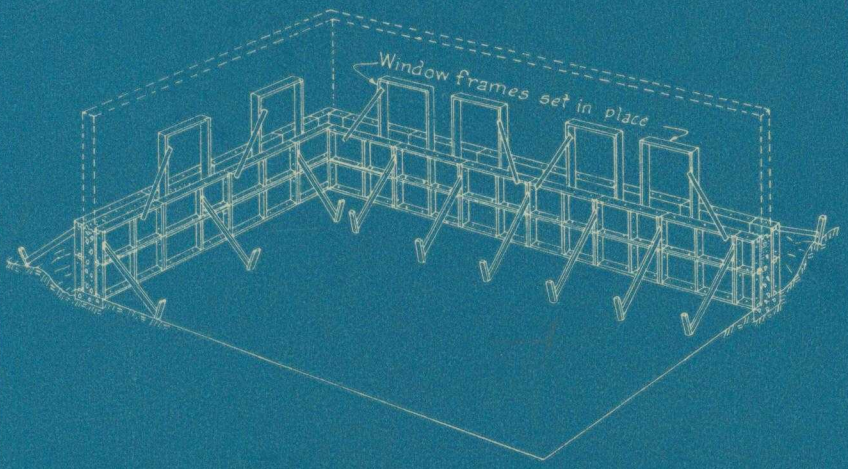


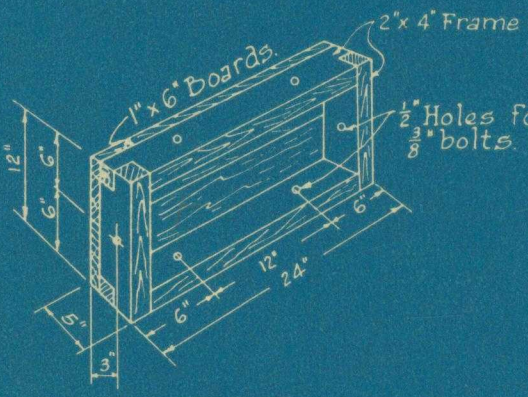
Fig. 11
Reinforcing bars as placed in cement walls

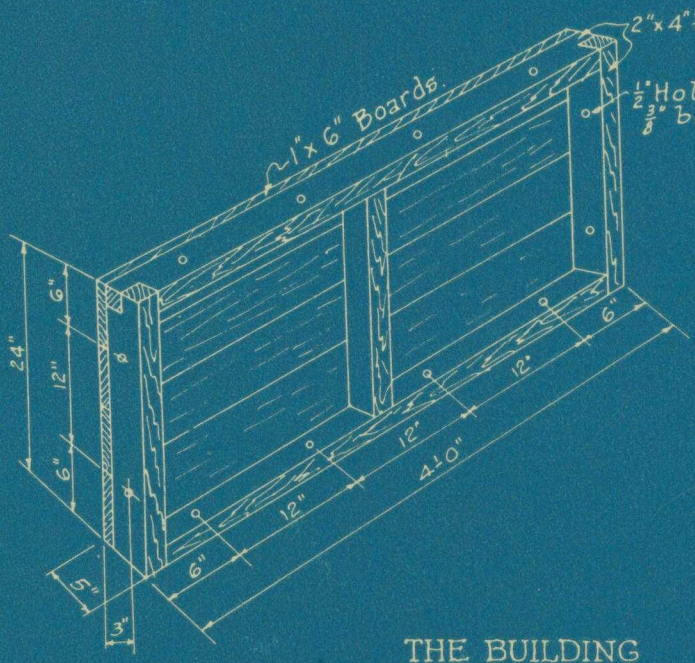
SUGGESTIONS ON UNIT FORMS

HOUSE WITH WALLS ERECTED BY UNIT METHOD

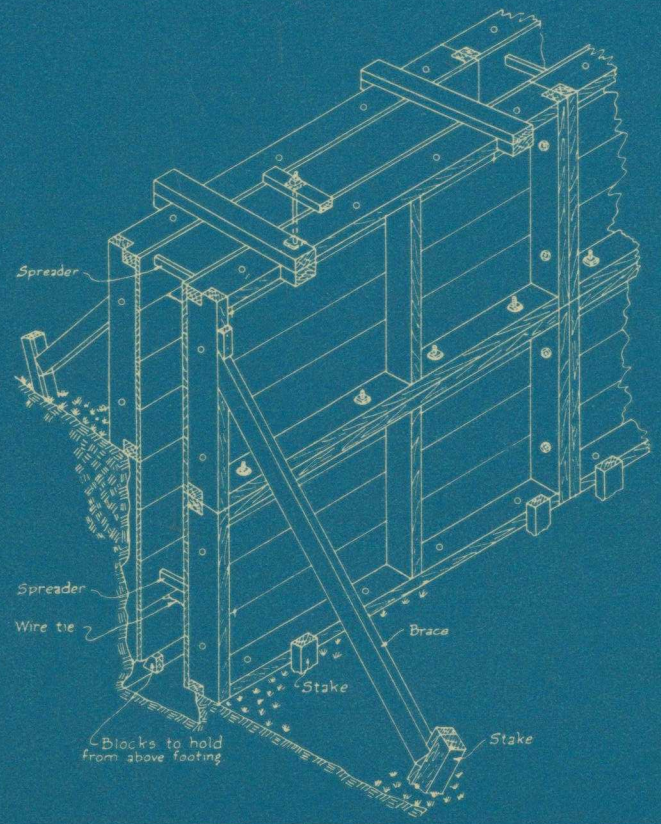


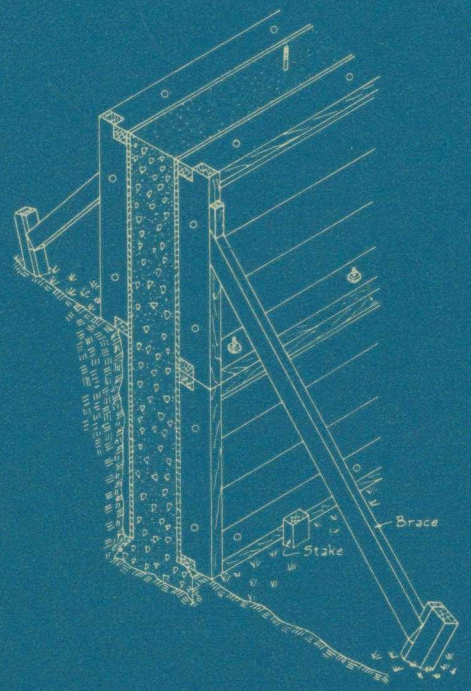
THE FIRST POSITION OF FORMS

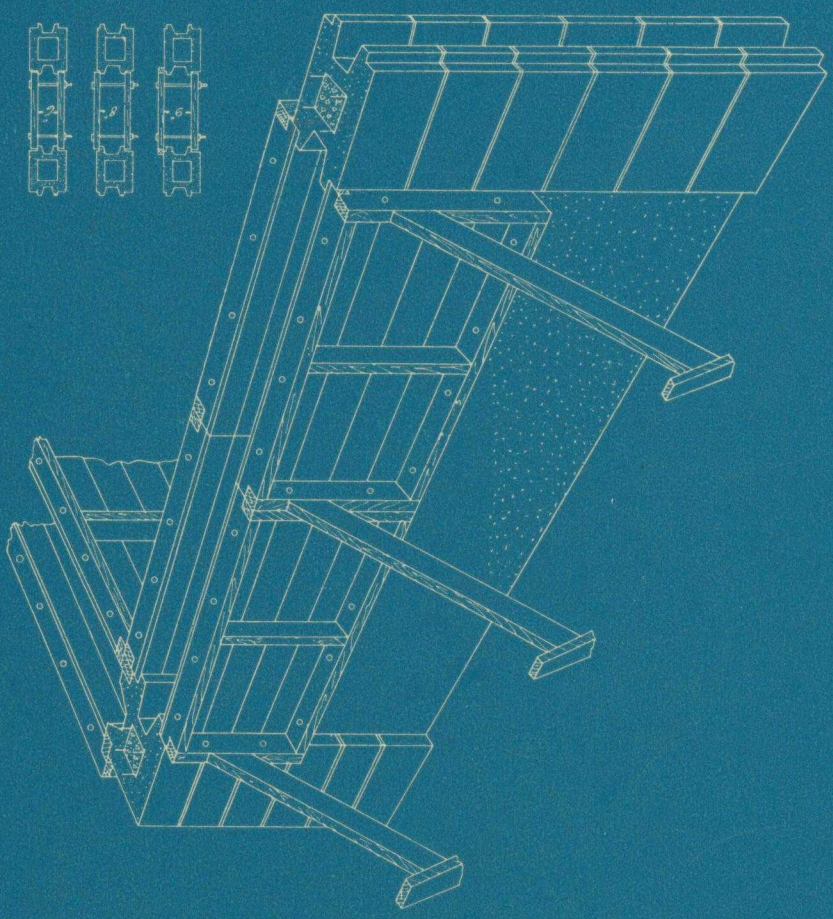




THE BUILDING
OF UNIT FORMS


Spreader
Spreader
Wire tie
Brace
Stake
Stake
Blocks to hold from above footing


Brace
Stake



USE OF CORNER AND PANEL UNITS
IN BREAKING STRAIGHT LINE MONOTONY

subject of engineering design only one general grade of reinforcing steel is considered. This can be obtained from any of the steel companies or through local building materials dealers.

Without going into details as to the physical and chemical properties of steel, it is sufficient to say that steel varies greatly in character; some is very much like wrought iron, while some may be compared to cast iron. In other words, one kind stretches and bends easily while the other is stiff and brittle. This should lead one to realize that not all steel is equally well suited for reinforcing cement work.

Regardless of whether plain round or square, twisted-square or deformed bars are used, the steel should meet what are known as the "Standard Specifications for Steel Reinforcing Bars," of the American Society for Testing Materials. Practically all of the steel companies manufacture reinforcing steel that meets these specifications.

In estimating for reinforcing steel it is best to increase the estimate by 10 per cent over the actual amount calculated for, to cover shortage resulting from cutting.

Reinforcing steel not only strengthens concrete against tension but in many cases makes possible the attainment of a required strength in a structure with considerable economy of concrete. It also serves to prevent cracks that may otherwise result from expansion and contraction under temperature changes. The principal reason for using steel instead of other metals is that the ratio of expansion of steel under temperature changes is so nearly like that of concrete that the two expand in a practically equal degree; therefore, there is no "breaking of bond" between the concrete and steel.

Reinforcing is particularly necessary in tanks or troughs, where freezing is likely to increase pressure. Foundations rarely need reinforcing. Building walls above ground usually do. Note Fig. 11.

The subject of reinforced concrete is a technical one and cannot be touched upon from the standpoint of design. Reinforcing for any structure should not be chosen by guess, although it is possible to specify in an offhand way safe practice for small structures such as the usual barnyard watering tanks or troughs, feeding-troughs, etc. Usually ¼-inch or ⅜-inch rods are used in tanks that are not greater than 2 by 8 feet inside dimensions, and are spaced from 6 to 12 inches center to center, both vertically and horizontally throughout the structure. See Fig. 10.

In reinforcing cement construction the quantity of steel required in a structure may vary from ½ to perhaps 1½ per cent of the cross-sectional area of the concrete. Columns and beams under excessive loads require as much as 4 per cent or more of steel. These figures are of course only general and may vary considerably in individual cases.

Steel used for concrete reinforcement should be free from rust in the form of loose scale that would prevent the concrete from bonding properly with it. To

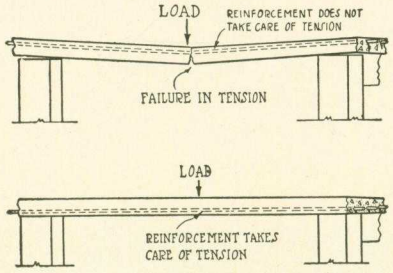


Fig. 12

be safe it should be brushed with a wire brush. Sometimes it is necessary to put the metal in a pickling bath, usually made by combining one part sulphuric acid and five or six parts of water, and left there long enough to remove the rust. The rods should be thoroughly washed in clean water to prevent any further action on the steel.

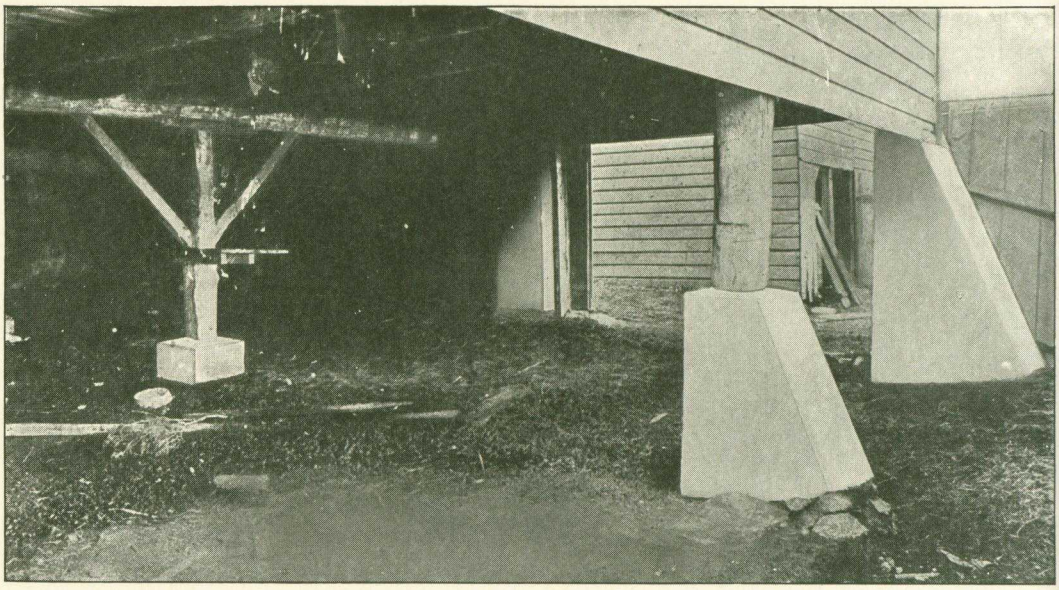
There are a number of patented types of deformed sheet metal marketed under various proprietary names used particularly in floor, roof-slab and partition construction, which in some cases serve as forms as well as reinforcing.

Before depositing concrete all reinforcing rods should be fixed in proper position so they will not become displaced while placing concrete. This is particularly important for construction that must be fire-safe, since it is necessary that the metal have the benefit of a certain amount of concrete covering, not only to prevent the steel from being exposed but to insure

effective bond. Reinforcing rods in such a structure as a tank, a silo or a cistern, for instance, should be wired together where verticals and horizontals cross.

In splicing reinforcing it should be lapped from 50 to 60 times its diameter. This method of joining is more effective as a rule than bending ends and hooking them together, since there is certain to be some slack where rods are so hooked, and if a strain is brought upon the concrete at such a place in the structure then the reinforcing is not effective in resisting tension. A ¼-inch rod should, therefore, be lapped with the rod which it joins not less than 12 and preferably 15 inches. Rods should be bound firmly together with wire wound around the lap. Patented "collar" clamps are also used. All rods used in beams and in floor and roof slabs should have the ends turned to an L-shaped loop or hook to form an anchor in the concrete. There should be at least 1 inch of concrete between the rods and the forms and never less than 2 inches between parallel rods.

When bending rods, bends should be made slowly. Force applied to the cold bar suddenly is quite likely to break it at the point of bending. Examine all bends and angles after made for cracks so as to detect any imperfections before placing the steel in the concrete. Reinforcing rods that are left projecting out of newly deposited concrete for the purpose of splicing other rods to them when work may be resumed should be protected against being struck or jarred, thus breaking the bond between the steel and the concrete. Reinforced concrete failures have resulted from the metal becoming misplaced while placing concrete. It is, therefore, essential that steel be placed exactly as called for in the plans. Note Fig. 12, illustrating correct and incorrect placing of reinforcement.



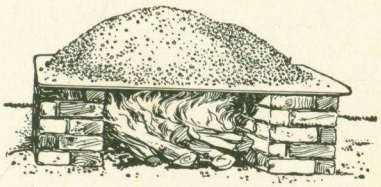
Repairing Foundations. A frequent cause of expense with frame structures is the necessity for repairing foundations because of failure of masonry or the rotting of sills and posts. Such repairs can be made of cement construction so that the work once done is done forever. To do work of this character it is usually necessary to jack up the building slightly. Rotted portions of posts are sawed off, then a form is built so that the concrete when smoothed off will almost touch the end of the sawed-off posts and after the concrete has hardened the jacks can be lowered and the building allowed to rest on the cement piers. See illustration above

Concreting in Cold Weather

A GREAT deal of cement work can be undertaken as well in winter as at other seasons. Indeed there is often more time and lower labor cost in winter than during the summer. Posts, drain pipes, rollers, slabs, watering troughs, tanks, floors, etc., can be completed indoors, and—with the exception of floors—the finished work can be put into place outside later. Such work can be done in barns, sheds, basements, etc.

All winter cement work must be done with extreme care. There must be established, through artificial means, the conditions that make for good work during favorable seasons of the year. For very large undertakings considerable equipment is necessary. For small jobs and moderately cold weather the equipment is simple and inexpensive.

There are various methods of protecting cement work in freezing weather. These include the heating of the materials and water to a temperature not higher than 145° F., and protection of the concrete until it is no longer in danger of disintegration through the action of frost.



Heating Sand

Common salt has been used in mixing water to prevent freezing of concrete when freshly deposited. But it has been found to merely lower the freezing point of the water and to cause the concrete to harden more slowly. The amount of salt used is generally one per cent of the weight of the water for each degree of temperature below freezing point to be counteracted. And since not more than 10 per cent can be safely used without probability of impairing the strength of concrete, salt affords protection only for temperature above 22 degrees—10 degrees below freezing. One and one-half pounds of salt to 18 gallons of the mixing water is a proportion used generally. Experiments indicate that salt in reinforcing concrete corrodes the steel and is therefore objectionable.

Salt should not be used if efflorescence on the surface of the finished work is objectionable.

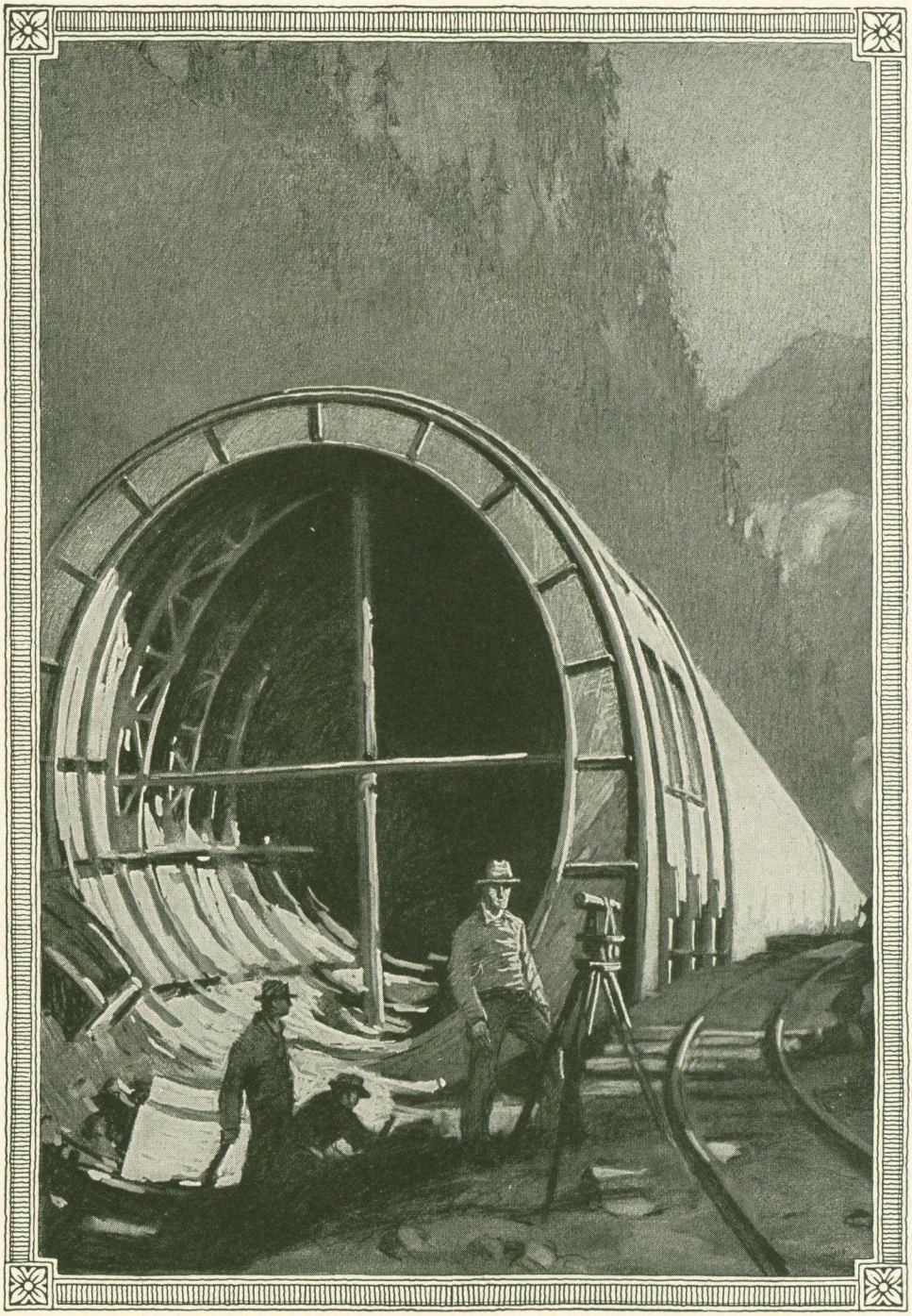
The methods of heating materials is the better practice where this can be carried out. Half-cylinders of sheet steel set on the ground in the form of an arch are used for heating sand and stone, and also metal culvert pipe and pipe coils supplied with steam. Another simple and practical method of heating is illustrated on this page.

Where steam is used, the sand and stone may be heated by piling them directly on the pipe coils or by covering the materials with tarpaulins and applying the steam directly to the materials. Short pieces of iron pipe attached to the boiler by lengths of hose are often stuck into the piles of material at points desired, thus allowing the steam to escape through the materials. This is regarded as a good method in that it avoids the rehandling of the materials.

Where sand heaters are used, precautions must be taken not to overheat or damage the material in direct contact with the heater. Some stone will crumble if exposed to intense heat. The cement, being only a small part of the mass of concrete, need not be heated.

Mixing water may be heated by placing a steam pipe in the water barrel, or by providing a suitable tank with a steam coil or a fire in a furnace underneath.

To make sure that the concrete goes into the work unchilled by cold weather, live steam is often kept in the drum of the mixer, the openings being covered with canvas flaps.



The New York Aqueduct

(The Greatest Water Tube in the World)

THIS, the most notable aqueduct ever built, is 111 miles long, with a diameter up to 17 feet. In places it runs 1,100 feet below the surface. It is subjected to a pressure as high as 90,000 pounds per square foot and delivers up to five hundred million gallons a day. Constructed on such a stupendous scale, this great water tube is expected to supply the needs of the metropolis for generations.

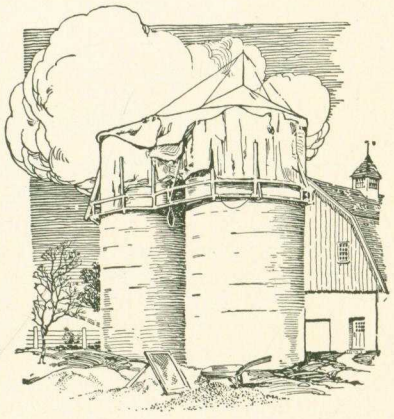
Such an undertaking demanded the most dependable materials, as well as the highest engineering skill. That more than four and a half million bags of ALPHA were used in this huge aqueduct is a significant tribute to the uniformly high quality of ALPHA—the guaranteed Portland Cement.

In conveying concrete a considerable distance from mixer to the construction, a cupful of gasoline poured into the empty concrete car on its return trip and lighted has been known to keep the fresh batch from being chilled.

Small stoves filled with coke and kept sufficiently warm to prevent freezing, may be used for heating buildings during the process of construction. To make them efficient, the work must be housed or covered with canvas to prevent the escape of the heat created by the stoves.

The protection of fresh concrete is treated on pages 19 and 27.

Since freezing temperatures materially retard the hardening of concrete and injury is likely to result, it is obvious that precautions should be taken to enable the fresh concrete to acquire strength rapidly. To insure that concrete will have sufficient heat to assist in hastening early hardening, materials and water should be heated so that the concrete when deposited will have a temperature not lower than 80 degrees Fahrenheit.



Note open stove under canvas flap

Plain mass work, such as retaining walls and abutments, will not require the same care and protection as thin walls, columns, beams and floor slabs.

Claims are sometimes made that concrete frozen before hardening may not suffer permanent injury if upon thawing it is not again exposed to freezing weather until sufficiently hardened to be unaffected by such exposure. Nevertheless every precaution should be taken to prevent freezing. If this is guarded against for at least five days, the danger of injury from subsequent freezing may be assumed to have passed.

Properly hardened concrete and frozen concrete look much alike. For this reason extreme care must be taken about removing forms from concrete that has been exposed to freezing weather. Forms must be left in place until the concrete has obtained sufficient strength to be self-supporting or to support imposed loads. If the surface becomes soft after application of hot water, this is good evidence that the concrete is frozen.

Fireproofing

No other structural material has given such a good account of itself when exposed to severe fire tests as concrete. It will not burn and is a slow conductor of heat.

Scarcity of timber in large sizes has resulted in a rapid advance in price of such material within late years and this has brought about a situation whereby absolutely fire-safe cement buildings can be built for the same cost or at least little greater cost than required for buildings that are thoroughly combustible.

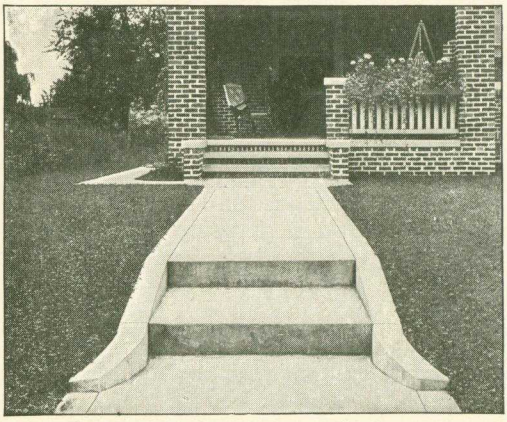
Unsuitable Aggregates. Marbles, granites, limestones, dolomites or magnesium limestones, and some gravels containing lime and magnesium will not withstand intense heat but break down. So where fire resistance is desired such materials should not be used as coarse aggregate.

Suitable Aggregates. For highest fire resistance aggregates should be selected with a view to their fire-resisting properties. Sand should be siliceous, while the coarse aggregates should be trap rock or slag or where great strength is not required, clean cinders. Trap rock, being of volcanic origin, was at one time in nature subjected to extreme heat, hence is well able to resist long and severe exposure to fire. In addition, it is a very tough rock and produces strong concrete.

Cinders are often used as an aggregate in concrete when great strength is not required, yet good resistance to fire is desirable. They must be free from ash and particularly from particles of unburned coal. The latter upon exposure to fire would, of course, not be fire-resisting and their burning taking place in the concrete, would cause its disintegration.

Protection of Reinforcement. In all fireproof construction it is very necessary that reinforcing be held in proper position while concrete is placed so the steel will have a sufficient protective covering to prevent heat from warping or melting it. As a general rule reinforcing steel in floor slabs should be protected by not less than a 1-inch covering of concrete, in beams by not less than 1½ inches, and in columns by not less than 2 inches.

Chimney Work. Concrete is used largely and very successfully in chimney construction and no doubt in many cases the heat where the gases enter the chim-



Good design for a low terrace

ney is 1000 degrees Fahrenheit. Even under continued exposure to the high temperatures of severe fires, the surface of exposed concrete does not soften to a depth exceeding one inch and usually very much less in ordinary fires, perhaps less than one-quarter of an inch. This softening action is due to the loss of the water of crystallization; in other words, the cement becomes dehydrated. However, this softened layer acts as a protection because it transmits heat slowly, and many tests have shown that the interior of the mass is not heated to a sufficient degree to cause the slightest injury.

A cement chimney that in use is to be exposed to considerable heat from furnace or boilers, should not be put into use until the concrete is at least 30 days old. Unless this precaution is taken, hardening will not have advanced far enough to have disposed of water used in mixing the concrete. Therefore, furnace heat would cause evaporation of this water with partial loss of strength to the concrete and considerable cracking usually evidenced by seams on the surface corresponding to the location of reinforcement in the structure.

Cement Buildings in Great Fires. The San Francisco and Baltimore fires have both become historical. In each of these cases cement buildings were about the only ones that suffered no great harm. Among the latest of great demonstrations of concrete's fire-resisting qualities was the Edison fire at Orange, N. J. In this case all buildings except those of cement, that were exposed to the ravages of this fire, were a total loss, while the cement buildings suffered relatively little damage and were restored to full usefulness in a short time at small expense.

Making Concrete Watertight

The fact that this porous concrete has been made has led to the marketing of various compounds intended to increase the watertightness of concrete. While many, if not all of these compounds accomplish temporarily at least the purpose intended, none of them are essential to securing watertight cement construction. The fundamentals of watertight concrete are contained in the chapter devoted to "Materials, Proportioning, Mixing and Placing." If properly graded materials are used a 1:2:4 or 1:2½:4 mixture will produce watertight concrete against the passage of water. If a head or pressure of water is to be resisted a 1:2:3 mixture will answer.

Density By Proper Grading of Aggregates. Proportioning concrete for maximum density, hence for watertightness, depends upon using well-graded pebbles or broken stone and sand, enough

sand being used to fill the air spaces existing in the coarse aggregate; finally, using enough cement to fill the voids which remain in the combined sand and pebbles. Many of the proprietary preparations commonly referred to as integral compounds are of questionable composition and none of them has been in use long enough as yet for one to say positively that the results obtained by their use will be permanent or that the composition of some of them is such as not to be injurious to the concrete.

Some of the earliest experiments toward increasing the watertightness of concrete consisted of adding a small amount of clay to the other materials. But as any quantity of clay over a very small percentage affects the strength of concrete and as it is not possible to add clay out on the job in the same manner that it is added when making laboratory experiments, such a practice is questionable.

Hydrated lime, often added to concrete mixtures, acts only as a void filler. The danger in it is that too much lime may be used, affecting the strength of the concrete. A little more cement instead of lime, would serve the purpose without the same danger.

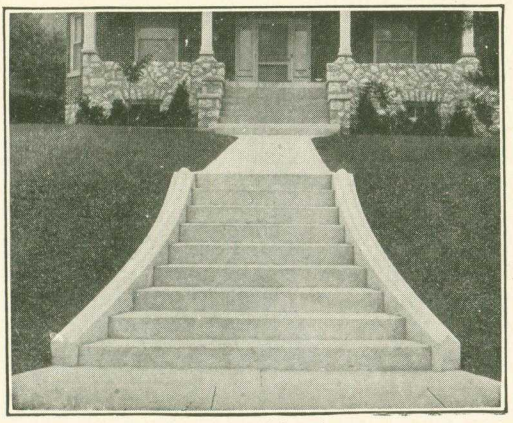
The use of integral compounds is apt to encourage careless proportioning and placing, with the idea that the use of the additional materials or compounds will make good the lack of carefulness.

Some Commonly Used Methods. Integral compounds that are not in the nature of void fillers combine with free chemical salts in the concrete to form insoluble compounds. Such preparations frequently contain sodium silicate, commonly known as water glass. In fact, such a preparation is useful when porous concrete must be treated to make it watertight. One part of the chemical dissolved in 3, 4 or 5 parts of water and applied as a paint at intervals of 24 hours will eventually fill the pores and render the surface watertight. Usually two or more applications are required, depending upon the porosity of the concrete. Another treatment known as Sylvester's treatment, which consists of separate soap and alum solutions, acts in a similar manner.

A formula that has been used generally is the following: Dissolve five pounds of powdered alum and one pound of lye in ten quarts of water. Use ½ pint of this mixture in every bucketful of water used in mixing the cement. For an outside waterproof wash, add ½ pint of this mixture to a bucket of water and thicken to a heavy wash with pure cement.

Result of Rapid Drying Out. Even though concrete may have been properly proportioned, mixed and placed, the mass may be porous as a result of allowing it to dry out too rapidly. The remedy is to leave forms in place and protect it as suggested elsewhere under the title "Protection of Fresh Construction." (Pages 19 and 27.)

Leaks in tanks, troughs, cisterns and similar structures sometimes result from the fact that no precautions were taken to join correctly the concreting of different days' work. When concreting is stopped the surface in the forms should be left rough so that there will be an opportunity for the concrete placed the following day to bond to the old concrete. The surface should be well washed, and painted with a cement grout paint mixed to the consistency of cream, applied immediately before placing new concrete. Some contractors when discontinuing work on tanks, silos and troughs, embed a 6 or 8-inch strip of tin or thin stovepipe iron into the concrete, leaving half of it to project in the concrete to be deposited the next day, also painting the surface with a cement grout paint immediately preceding the placing of fresh concrete.



A graceful design

This has been found to be a very effective method of preventing construction joints from opening up.

Cement Block, Cement Brick and Cement Structural Tile

It is not so many years ago that concrete was recognized by the average person only when in the form of common rock faced cement block. While most structures in which this building unit was used are still in existence, this type of cement block has practically fallen into disuse. One reason for this is undoubtedly the fact that structures made of imitation rock faced cement block have from the beginning been unattractive, if not ugly. Again the early makers of cement block did not know, as is known now, many things which must be observed in making concrete in order to insure a thoroughly satisfactory product.

Of late years the artistic side of the possibilities of cement has been given more thought and attention, with the result that we have cement block and cement brick with surfaces faced with selected aggregates that rival and often exceed in beauty and durability any of the natural buildings stones. Many large hotel and apartment buildings, banks, schools, theatres, and other pretentious structures are now built of precast cement stone. Few, except experienced persons, can detect the difference between the exterior of these structures and others which they seem to imitate but which most persons will agree they excel from the standpoint of appearance. In other words, few persons know that the building material is artificial or manufactured stone instead of quarried stone. The reason for this is because the knowledge of concrete and how to use it has advanced to meet artistic as well as strictly utilitarian ends. The Alpha Portland Cement Company will send to anyone especially interested, several service sheets showing the wide possibilities of concrete in trim stone, sills, lintels, and cast construction generally.

Cement blocks are made in a wide variety of form for an equally wide variety of use. Silos, foundations, building walls, corn cribs, grain tanks, well casings, catch basins and chimneys all are built of cement block, and the block themselves may be of almost endless variety of shape, form and surface appearance, from the plainest type used in a structural wall that is finally to have a stucco finish to those faced with selected aggregate mixtures giving the appearance of natural stone.

The same principles of cement practice apply in the making of most cement products as would apply in any other use of cement work, namely, some particular mixture is best for a certain class of product; the quantity of water used should be carefully governed; and the materials should be clean and free from foreign matter.

The accompanying tables will help in estimating.

MIXTURES FOR BODY OF BLOCK

Proportions for body of block	Cu. ft. of sand and stone per bbl. of cement			Quantities of materials necessary for 1 cu. yd. of concrete			Quantities of Materials necessary for 100 8″x 8″x16″ standard cement block allowing 33% for air chambers		
	Bbl. of Cement	Cu. ft. Sand	Cu. ft. Stone	Bbl. of Cement	Cu. Yd. Sand	Cu. Yd. Stone	Bbl. of Cement	Cu. Yd. Sand	Cu. Yd. Stone
1:2:4	1	8	16	1.51	.45	.89	2.20	.66	1.30
1:2½:4	1	10	16	1.39	.51	.82	2.04	.75	1.20
1:2½:5	1	10	20	1.24	.46	.92	1.81	.68	1.35
1:3	1	12	..	2.25	1.00	...	3.3	1.46	....

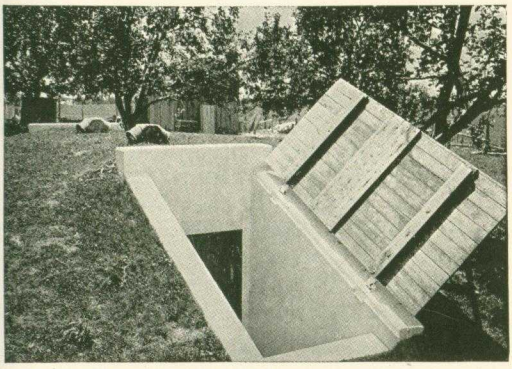
MIXTURES FOR FACING

Proportions for facing	Cu. ft. of sand per bbl. of cement		Quantities of materials necessary for 1 cu. yd. of concrete		Quantities of materials necessary for 100 8″x 8″x16″ standard block	
	Bbl. of Cement	Cu. ft. of Sand	Bbl. of Cement	Cu. ft. of Sand	Bbl. of Cement	Cu. ft. of Sand
*1:1½	1	6	3.86	23.2	.53	3.20
*1:2	1	8	3.1	25.1	.43	3.45

*Based on facing used in surface layer ½″ thick.

ALPHA CEMENT — HOW TO USE IT

One peculiar advantage possessed by the most popular forms of cement block is that they can easily be laid so as to secure hollow or double wall construction, thus introducing into the wall the desirable feature of insulation.



Storage cellar with cement block walls and monolithic roof and hatchway

Rough cast block form the most desirable backing for a stucco exterior. In such a cast the appearance of the block does not count so much as strength and density because irregularities of surface are covered by the coat of stucco.

When concrete is to be faced with a richer mixture in which a selected aggregate is used, there should be but little difference permissible in the consistency of the two mixtures. The only reason why the facing mixture may contain less water is because any excess water from the backing mixture will penetrate the face mixture by capillary attraction before the hardening process sets up or has advanced very far.

Practically all cement block, brick, structural tile, sewer pipe, drain tile and similar products are manufactured by machine. They should be machine-made for the best results, that is to say, strength. Strength, of course, is governed in part by correctly proportioned mixtures of proper consistency and correct curing of the finished product.

Some types of block machines are hand operated, some may be operated either by hand or power, and some are power operated exclusively. In the last type of machines there is generally a battery of tampers to compact the concrete in the mold. Block machines are further classed as face-up or face-down machines. Some consolidate the concrete in the mold by a tamping process, others by direct and increasing pressure.

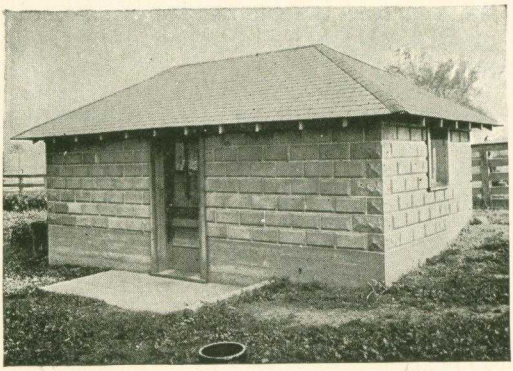
Usually when the block machine used is a type of press, the entire mold is filled before pressure is applied but it is always well to partly fill the form or mold slightly compacting this concrete before the remaining quantity necessary to fill it is added. In at least one type of block, manufacture is done by the casting rather than by the pressure or tamping process. In other words, the machine is really a battery of molds which receive a very wet mix.

The accepted shape of cement block is such that the exposed surface is a rectangle. Block may or may not extend entirely through the building wall in which used but in every case provision is made for an air space in walls and the means by which this is secured varies widely and in many cases is governed by patent covering the machine or controlling method of manufacture. The manufacture of cement block, if one is careful to select suitable machinery, and with the same care observe the requirements of good cement construction practice, is within the range of anyone's capabilities. However, most block and other cement products are made by so-called cement products plants. This business is expanding rapidly because of recent developments in the cement products field which have resulted in improving both in quality and appearance many of the older and better known cement products and in developing new ones, or new uses for modified forms of the older ones.

Probably the most important detail of

Laying foundation and walls of cement tile. No forms required. Insulation is thus ideally provided for

ALPHA CEMENT — HOW TO USE IT



Combination of block and monolithic method in building a spring house. The slab in front of doorway is an excellent idea

cement products manufacture is the curing or hardening of the product, which is the final step in manufacture preparatory to use; and this detail of manufacture is the one most often slighted or least appreciated for its importance. As soon as possible after removing cement products from the machine they should be protected from sun, wind and other drying influences, as suggested on page 19. Then, if possible to do so, they should be subjected to continuous exposure to water spray or, better yet, to curing in a steam chamber built especially for the purpose. Fuller details of these various fundamentals can be found in several standard publications of the Portland Cement Association which will be supplied on request.

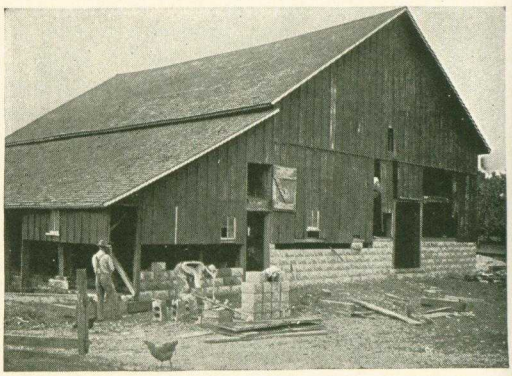
Cement Brick. Because of the many improvements that have been made in the manufacture of cement brick within the past three or four years, this cement product is rapidly winning increased favor. The essentials of manufacture are like those for cement block. The common mixture used is 1:3 in which the aggregate is clean, coarse sand. Where it is desirable to face the brick with a richer material or a selected aggregate surface, such facing mixtures should be in the proportions 1:2, the aggregate being then selected colored sand, granite screens, marble chips or a combination of several selected aggregates to secure the desired texture and color of surface.

Cement Structural Tile. In many respects, cement structural tile are not unlike certain types of cement block, the difference being in the manner in which air cells are introduced in the block by the arrangement of webs not unlike the cross-section of some types of clay building tile. Cement structural tile have not had a wide general use, although they have been and are being used at the time very extensively in several parts of the country where enterprising manufacturers have established up-to-date plants to produce this cement product. In several parts of the country large industrial housing developments are being advanced with cement tile as the exclusive building unit.

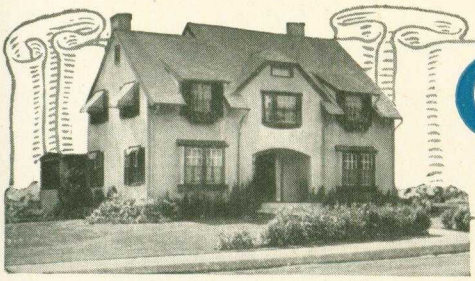
The Alpha Portland Cement Company issues from time to time a pictorial magazine entitled ALPHA AIDS, dealing with cement improvements and interesting features of the cement business.

We do not wish to waste any numbers of this magazine, but will be glad to put on our free mailing list any engineer, architect, contractor, dealer or property-owner who has a real interest in the use of Portland Cement.

Merely address Service Department, ALPHA PORTLAND CEMENT COMPANY, giving your full name, complete address and ***your business.***



Putting cement-block foundation under old barn. In this way many farm buildings can be given a longer lease of life



Cement Houses

Loring and Phipps, Architects

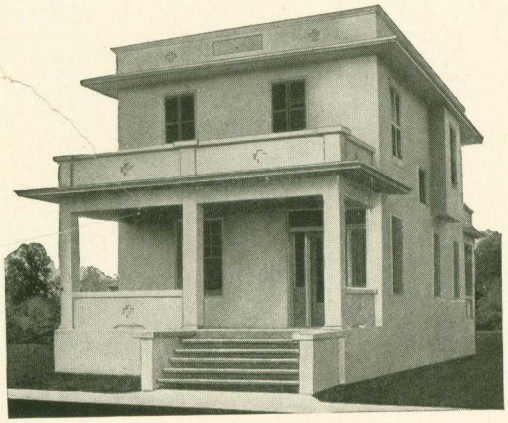
ALTHOUGH there are perhaps many thousand examples of the satisfactory use of cement in house construction, only within the past two or three years has the cement house attracted the interest which its merits warrant. The reason for this is probably due to the fact that the average architect specializing in house construction has lacked opportunity to inform and educate himself sufficiently in the subject of cement construction design.

The greatest impetus given to cement house construction within recent times developed as a result of housing needs in connection with various industrial enterprises associated with the late world war. Speed of construction in such cases was imperative; elimination of unnecessary demand upon rail transportation was also imperative, as railways were pressed into more intensive service than ever before in moving munitions and other military necessities. Industrial housing development under such conditions, therefore, resolved itself into adaptability of local materials—those which could be quickly made available for use and which require a minimum of transportation. Naturally cement was the first to attract attention under such conditions. As a result, a number of large and notable industrial housing developments in various parts of the country where war industry was most active were quickly made available through the application of cement construction. Not all of these projects by any means represent the best possible results in the use of concrete. However, the prosecution of these projects attracted as never before proper attention to cement's adaptability. Among the results were the development of various systems of cement construction, aimed not only at avoidance of monotony of design and speed of construction but economy of construction with more artistic design. At the same time, as intimated elsewhere in this booklet, the quality and appearance of cement products, such as cement block and brick were raised, thus enabling new standards of cement house construction. Now cement building seems to have almost reached the goal of deserved attention and appreciation.

If for no other reason than contributing to a reduction of our national fire losses, homes as well as other structures should be firesafe. During the early part of 1921, statistics of fire losses showed that, as has been true almost without exception during the past 14 years, our national fire losses continued to increase. In the period of 1921 under consideration these losses in the United States alone were averaging more than a million dollars a day. Probably cement's first claim to consideration for house construction is its fireproofness. With this fact in mind and appreciation for the necessity of stopping this unnecessary drain on our national wealth, houses

Year	No. of Cities	Building	Fire Losses	P. Ct. of Fire Losses to Building
1907	83	$656,084,169	$215,671,250	32.8
1908	105	626,448,075	238,562,250	38.0
1909	120	889,723,000	203,649,200	22.8
1910	120	846,712,000	234,470,650	27.5
1911	140	849,977,101	234,337,250	27.5
1912	145	931,256,019	225,320,900	24.1
1913	149	879,560,000	224,728,350	25.5
1914	156	785,385,637	235,591,350	30.0
1915	156	822,197,440	182,836,200	22.2
1916	160	996,603,346	231,442,995	23.2
1917	160	706,810,079	267,273,140	37.8
1918	163	432,480,436	317,014,385	73.3
1919	163	1,310,398,691	269,000,775	20.5
1920	163	1,408,610,001	330,853,925	23.5
Total 14 years		12,142,245,994	3,410,753,620	28.1

ALPHA CEMENT — HOW TO USE IT



Chatham Real Estate and Improvement Co., Savannah, Ga.
See floor plans below

as well as other structures should be built firesafe.

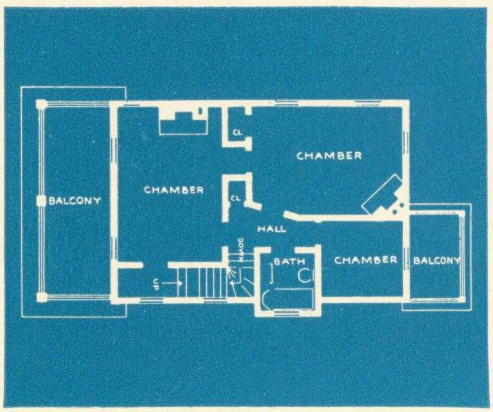
The table on page 35, taken from Bradstreet's, is impressive any way it is looked at but is made more impressive by the total of the figures listed.

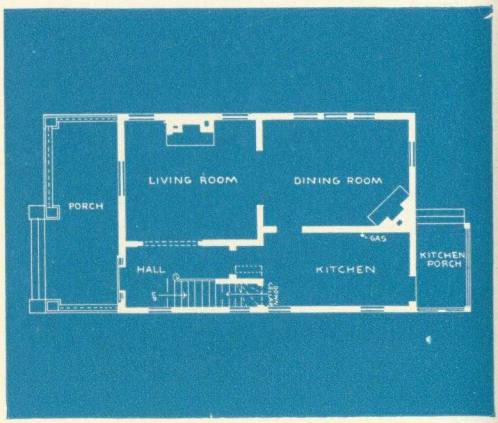
These figures show that in the 14-year period covered, our fire losses were in excess of one-fourth of the value of new building construction. In other words every four years we burn up the value of one year's entire construction program. A million dollars a day is a sum worth saving. Firesafe cement houses will stop fire loss in homes.

The type of cement house best suited to the home builder's individual requirements is a matter that should be discussed with the architect. A number of systems of construction involving principally the forms or molds used have recently won renewed attention. Among these may be mentioned the Morrill System, Lambie System, Schub System, Ingersoll System, the Metaforms System, the Hydraulic Steelcraft System, Fellgren System, Richardson System, and the Van Guilder System. There are still others. As mentioned, some of these although referred to as systems of construction, are really systems of forms to facilitate construction.

The great interest taken by employers and municipalities in the building of small homes of permanent and comfortable types led the Alpha Portland Cement Company to prepare a number of Service Sheets dealing with houses of the following types: (1) Gunite and frame, (2) Monolithic wall, (3) Pre-cast Slab and Beam, (4) the "Ingersoll" type, a large number of which were built at Phillipsburg, N. J., close to one of the Alpha Cement plants and general offices. Space is lacking here to describe each of these methods in detail. A half-tone view of one of the Ingersoll type of house is shown and on page 41 there is a suggestion of the method used in this type of construction. The Alpha Cement Company will send to any one interested in the building of a number of small houses free copies of the four Service Sheets mentioned. The Portland Cement Association has comprehensive data on all of these systems which it is glad to furnish without obligation to interested persons.

Cement Surface Finish. To fully develop the decorative and architectural possibilities of cement construction, the builder must not only have sufficient ingenuity to carefully plan and use the necessary forms but must consider giving additional variety





and life to the surface by the use of colored sands, selected aggregates and final methods of surface finish.

Most cement buildings do not warrant any special attempt to give a surface finish

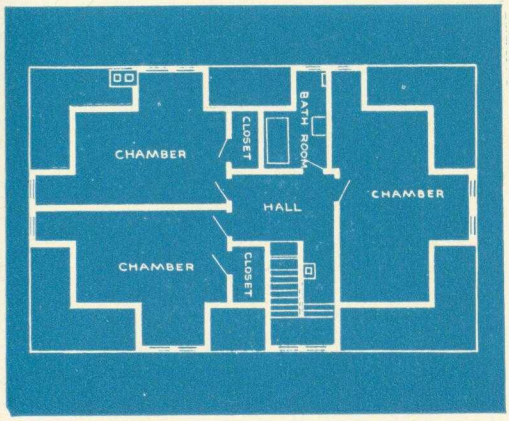
W. H. Parrish, Designer and Builder *See floor plan below*

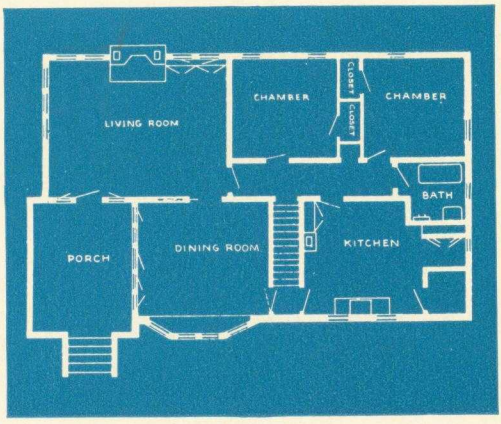
other than the natural one which results from exposing the surface that was in contact with the well made forms, other perhaps than to patch up minor irregularities of surface such as small stone pockets, a few of which are inevitable regardless of how carefully concrete may be placed.

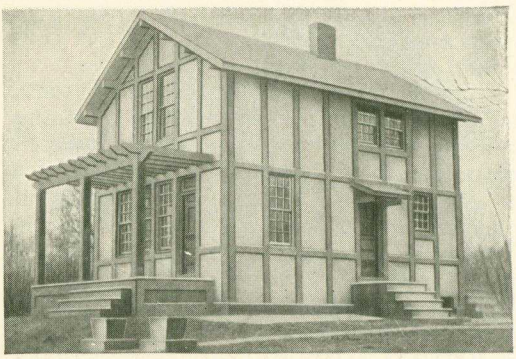
The simplest surface treatment that can be applied principally to secure uniformity of color, is to go over the surface with a paint consisting of one part cement and one part fine sand mixed with enough water to form a solution about like thick white wash which should be kept constantly stirred while being painted on the surface.

In the order of simplicity the next surface finish that can be given concrete is to wash from the particles of aggregates near the surface the film of cement coating them. With the exposure of aggregates the natural color which they have is brought to view and the dull gray monotony of the concrete as it appeared after form removal is considerably relieved.

The most attractive surface finishes are, in a large part, prearranged when mixing and placing the concrete, that is, selected aggregates such as marble chips, granite screenings, hard black slag, feldspar and micaspar are used instead of ordinary sands, thus contributing their color and sparkle to the surface. Mixtures are prepared and placed in the usual way. After the concrete has hardened so that the forms may be safely removed, the surface to be treated is gone over in one of several ways to produce the desired final finish. Usually this is done by washing off the film of cement that coats the particles and in that way revealing their color. If the forms can be removed within 24 hours after placing the last concrete, it is usually possible to wash off the surface film of cement coating the aggregates by merely scrubbing the surface with a stiff wire-bristled brush while the surface is kept wet with water. If, however, the concrete has become too hard to permit exposing the aggregate in this manner, then an acid wash, usually consisting of one part of common muriatic acid to three or four parts of water is applied with a brush. The surface is lightly scrubbed during the application of acid solution until the film of cement is loosened from the aggregate. The work must be done carefully and systematically with running water from a hose available so that the action of the acid can be kept under constant control to prevent its action from going so far as to loosen the aggregate particles from the surface.







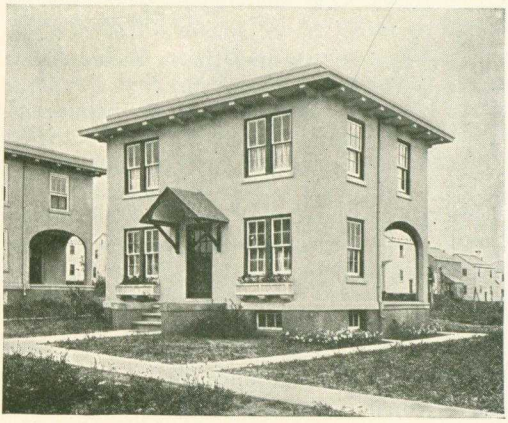
Pre-cast slab and beam house of Simpson Craft type

Another method of finishing a concrete surface is to tool it in the same way stone cutters tool stone. If such a surface finish is contemplated, it must be anticipated by giving particular attention to selecting aggregates and still greater care to proportioning the concrete mixtures so that the aggregates will be of as nearly perfect grading as possible, thus requiring the lowest possible amount of cement to bond particles together and thus preventing the natural color of the cement from controlling the surface color of the concrete.

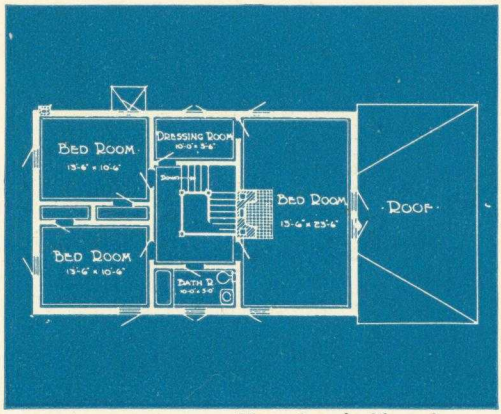
Bush hammering is more often used in connection with concrete proportioned of common aggregate than of selected ones. For bush hammering the concrete must have hardened sufficiently to prevent the use of the hammer from loosening particles of aggregate from the surface.

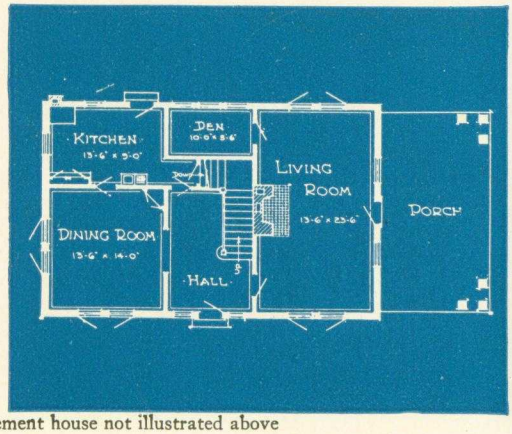
Portland Cement Stucco. Stucco is a mixture of Portland cement, sand and water, often with a certain portion of hydrated lime which helps to make the plaster "fatter" and in that respect easier to apply. Stucco in various forms has a wonderful and growing popularity. It does not make a building fireproof, but it gives a large measure of fire protection to a structure that is of non-fireproof materials. It also preserves such buildings against rapid depreciation and naturally eliminates the necessity for frequent maintenance such as painting and the many common repairs that would be necessary without it. It also contributes to a warmer and drier interior thus making it a building easier to keep warm in winter and cool in summer.

Stucco can be applied so as to present a variety of surface finishes. The recommended practice for using stucco has received much attention on the part of a committee of the American Concrete Institute which has long studied the deficiencies of stucco work as ordinarily practiced and has therefore written recommendations



Ingersoll house of 6-room type





Floor plan of still another type of cement house not illustrated above

for its use with a view to insuring the greatest measure of success and satisfaction. A booklet containing this Committee's latest report which is in the form of a specification for stucco work, will be gladly sent to those interested.

Weather Conditions. Portland cement plaster frozen before it has hardened will be ruined. Freezing after it has hardened will not injure it. Stucco should be protected just like fresh concrete.

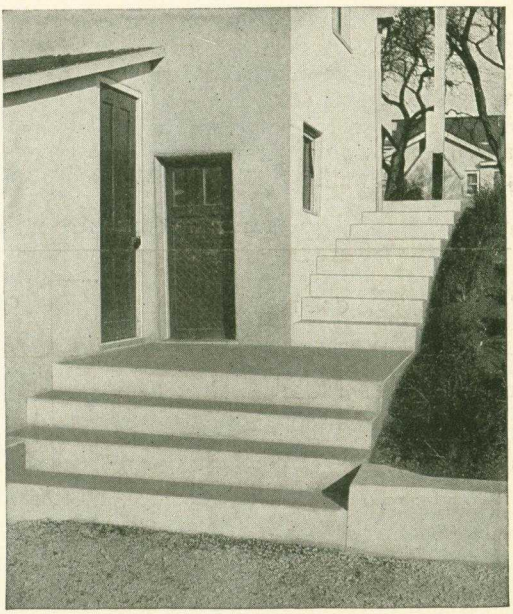
Stucco on Brick or Masonry. The surface must first be thoroughly scrubbed with brush and water. If it had been painted previously, the paint should be removed before scrubbing. Immediately before applying stucco the surface should be saturated with water to prevent it from absorbing moisture from the plaster. Mortar joints should be picked back so as to provide a better bond between wall and plaster. Plastering should be started at the top of the wall and continued downward. The work should be done continuously. The materials should be measured carefully for every batch of plaster to insure uniform color.

If preferred, a brick or masonry surface may be furred and treated like a frame structure.

Applying the final coat of Portland Cement Stucco

Lathing and Trim. Before applying stucco it is necessary to fur-and-lath the exterior of a frame structure. Furring strips 1 by 2 inches should be nailed to the wall vertically, at distances apart corresponding to the studs in the building. Wood lath, metal lath or some metal fabric is then fastened to the strips in practically the same manner as an interior wall is prepared for plastering. When the old weather boarding is left in place, all old trim should be brought out flush with the finished wall surface or made to project beyond it.

Number of Coats. As a rule two coats of plaster are used in stucco work unless some particular final finish is desired, when a third coat is applied. The first, or scratch coat as it is called, is generally composed of two parts of clean well-graded sand to one part of cement, with hydrated lime added in an amount equal to 10 per cent of the cement. Often a small quantity of cow hair is added to the mixture for the first coat to give greater bond or key with the lath. This coat should be from ⅜- to ½-inch thick, and before it has become hard it should be scratched with some kind of a tool having



Cement makes the back of this home look trim and substantial

ALPHA CEMENT — HOW TO USE IT

Attractive Florida home constructed with cement blocks of varying sizes

saw toothed edge so that the surface will be roughened to form a good bond for the next coat.

Pebble Dash Surface. Clean pebbles of uniform size, mixed in a thin cement-water paint and then immediately thrown against a freshly plastered surface, gives a very attractive appearance to a stucco exterior. A similar surface may be obtained by mixing cement and lime paste to the consistency of thick cream and then adding 1 part of washed pebbles to 5 parts of the mixture. This may be applied with a trowel or dashed against the wall with 6-inch wood paddle.

Broom Dash Finish. A mixture of 1 part of ALPHA Portland CEMENT, one-tenth part hydrated lime, and 1 part of fine white sand, mixed dry to an even color, with enough water to give creamy consistency may be thrown with a whisk broom against a dampened wall.

Special Service Sheet on Cement Surfaces, Trimstone, Etc.

Several Service Sheets, sent by the Alpha Portland Cement Company to any one interested, deal more specifically with the large subject of surface finishes of concrete, the manufacture and the use of cement trimstone, sills, lintels, etc. These sheets show the application of the methods to buildings of various types, large and small.

Colored Effects in Portland Cement stucco may be secured by the use of mineral pigments. While most colors will fade somewhat in time, blacks are generally classed as safe, the carbon blacks being preferable to lampblack. See table below.

Mr. W. H. Parrish, Carnegie, Pa., designer and builder of the dwelling illustrated on page 37, says, "The cost is little more than for good frame construction. Cement houses not only look well but can be heated for less money. They are sanitary, everlasting and absolutely fireproof."

Ingersoll System of Wooden Forms

The illustrations on page 41 show the Ingersoll form system referred to in a description of the Phillipsburg housing development. This method is more particularly adapted to industrial houses where

TABLE OF COLORS TO BE USED IN PORTLAND CEMENT

Color Desired	Commercial Names of Colors for Use in Cement	Pounds of Color Required for Each Bag of Cement to Secure—	
		Light Shade	Medium Shade
Grays, blue-black and black	Germantown lampblack	½	1
	Carbon black	½	1
	Black oxide of manganese	1	2
Blue shade	Ultramarine blue	5	10
Brownish-red to dull brick-red	Red oxide of iron	5	10
Bright red to vermilion	Mineral turkey red	5	10
Red sandstone to purplish-red	Indian red	5	10
Brown to reddish-brown	Metallic brown (oxide)	5	10
Buff, colonial, tint and yellow	Yellow ochre	5	10
Green shade	Chromium oxide	5	10

several units of similar design and plan are to be built of what might be called standardized houses. Footings and basement floor are placed in one operation after which form work for the entire house is erected at one time and the house is completely cast during one operation, the cement mixture being poured from the roof. The entire process can be completed in less than a week and the forms removed and put in place for another house.

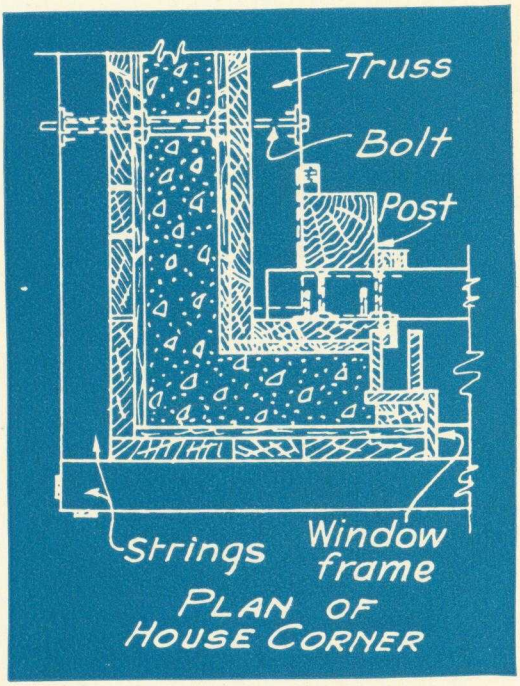
An interior rigid frame work for the two stories is first erected. This frame work consists of columns continuous throughout all stories and held in their positions rigidly by trusses. On this supporting framework are hung the forms which mold the concrete of the outside and partition walls, the stairs, floors and roof, the cornice, brackets and other ornamental work.

The forms are kept from bulging by means of iron bars which extend through forms and wall. Wooden separators are placed between the inside faces of the forms, so that the entire form structure is absolutely rigid before any concrete is placed.

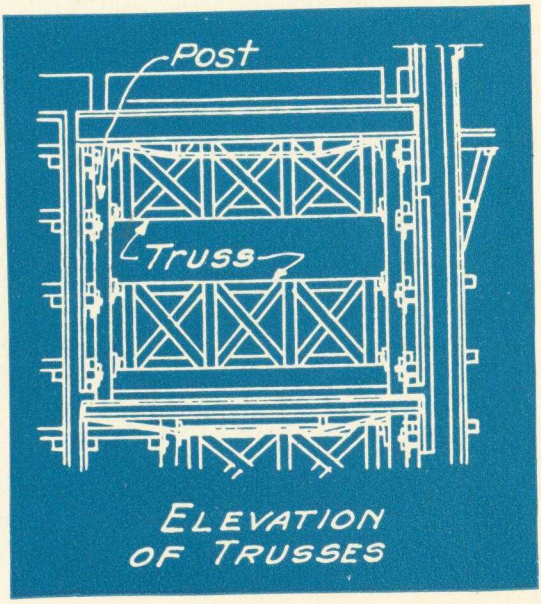
All reinforcing steel is placed in the form before the house is cast. The vent and soil pipes, electric conduits, metal flue lining for the chimneys, window frames, door bucks, furring strips, nailing blocks, etc., are also set in place before the concrete is cast.

Page 38 shows a photographic view of one of the 6-room type of Ingersoll houses. Forms were first perfected for the 4-room type, and a good number of both styles have been erected at Phillipsburg, N. J., and elsewhere. Pleasing variations are possible by changing the style of the front entrance and by introducing the color element into the surface finish. Ask us for full service sheet if interested in the details of construction.

Typical Working Details of the Ingersoll Forms

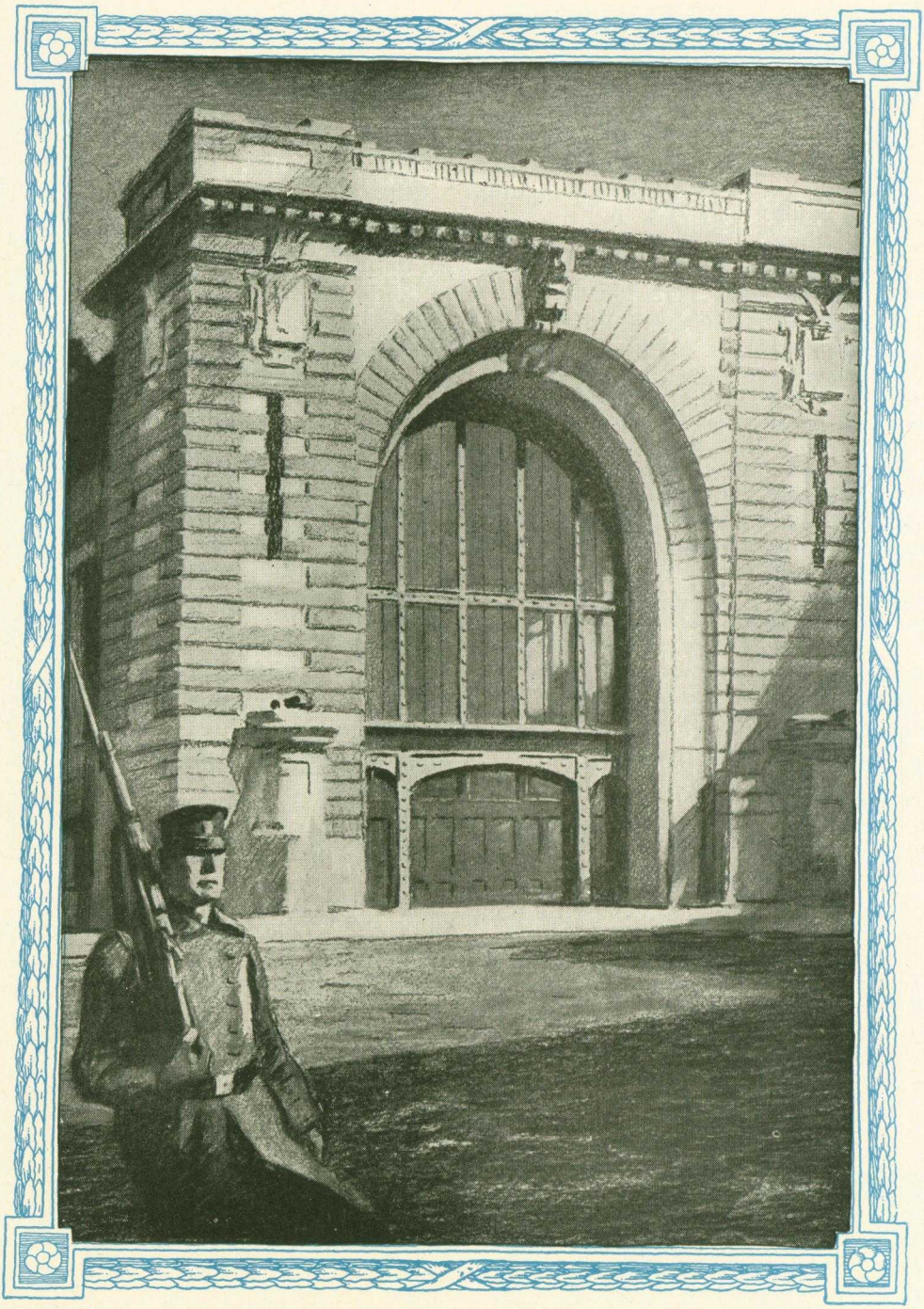


PLAN OF HOUSE CORNER



ELEVATION OF TRUSSES

DETAIL OF END CONNECTION FOR STRINGS

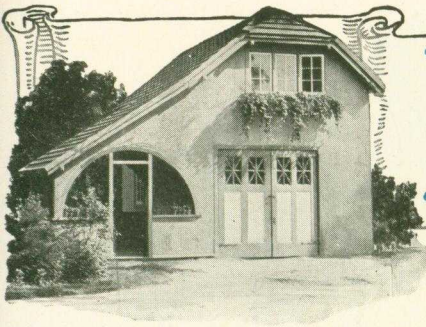


Naval Academy Armory

(*Annapolis, Maryland*)

THE impressive appearance of this Government structure is the result of the architect's efforts to make the building symbolize the strength of the United States Navy. The severe architectural treatment—the impressive arched entrance—the massive block construction—all suggest strength and permanence.

The materials used in the construction of this building, as in all Government work, were required to meet exacting tests. The engineers who were responsible for the quality of the work used ALPHA, the Guaranteed Portland Cement.

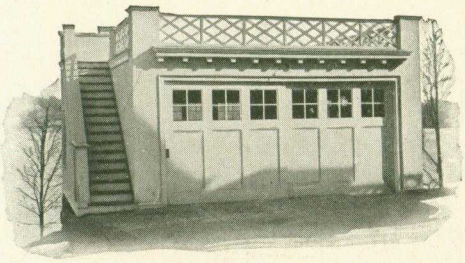


Building a Cement Garage

THE owner of an automobile demands more than a mere housing. He aims to have a building that is distinctive in design, fireproof, durable and equipped to make the necessary work on the automobile easier.

The logical location for the garage is at the rear of the house. This is a point, however, that can be discussed only generally, as the individual requirements may make it necessary to have the garage elsewhere on the property.

In deciding upon the size of the garage, future possible requirements should be anticipated. Even where it is fairly certain that there will never be more than one automobile, it is often a good idea to make accommodations for two. There is then room for a visitor's automobile or half of the garage may be rented to a neighbor.



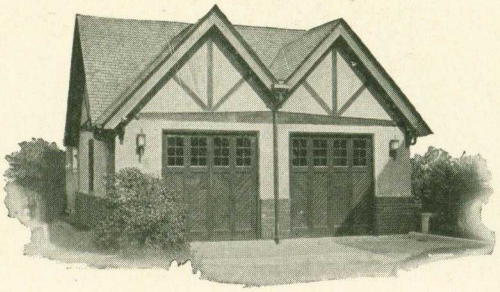
It is most important that the garage be absolutely fireproof. No inflammable building materials should be used. The fact that modern garages everywhere are built of cement construction is a strong indication that architects and builders recognize this material as the proper one for garage construction.

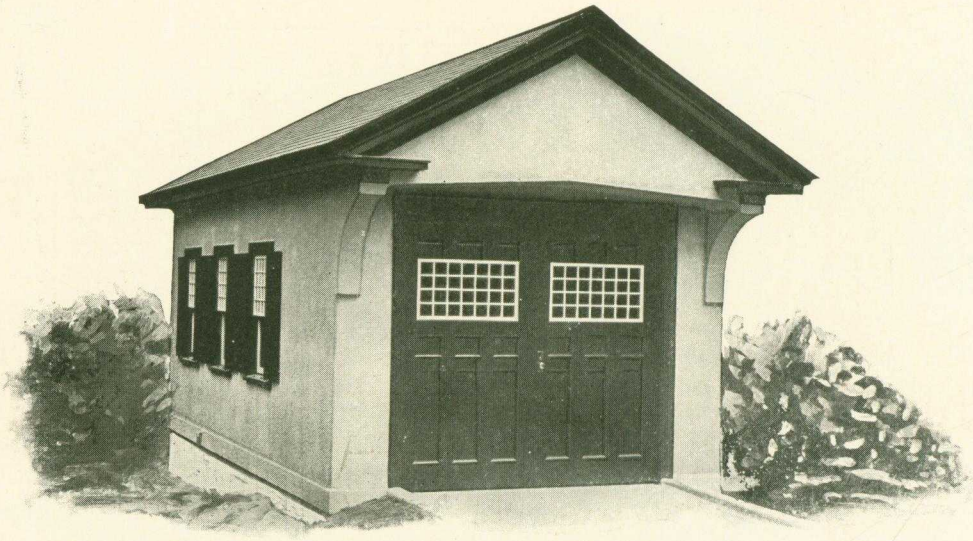
The many advantages of cement over other building materials for garages are obvious. It has demonstrated its fireproof qualities in hundreds of notable instances. Insurance companies give lower rates on property protected by concrete. A cement garage is easily and cheaply built, is permanently attractive, and is everlasting. It is dry at all times—and is warm in winter and cool in summer. It is clean and easy to keep clean. It is economical because it eliminates the necessity of painting and repairs.

The photographs reproduced here show some pleasing effects in garage construction secured by the use of cement. The blue-prints on the succeeding pages suggest attractive designs for inexpensive types of one-car and two-car garages.

There are almost endless variations in garage design. Hence, the illustrations of this chapter can be only general suggestions.

The building of a garage is very much like that of a house. Generally it is constructed at the time the house is built. Further details of interest may be found elsewhere in this book under the title of "Small Cement Buildings." (Page 60.)



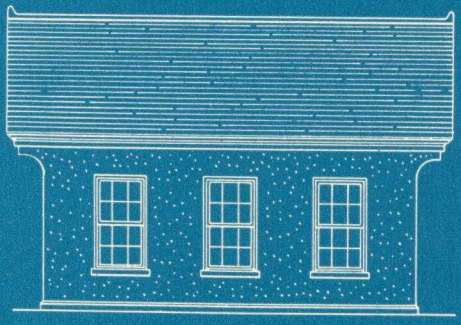


· AN INEXPENSIVE ONE CAR GARAGE ·

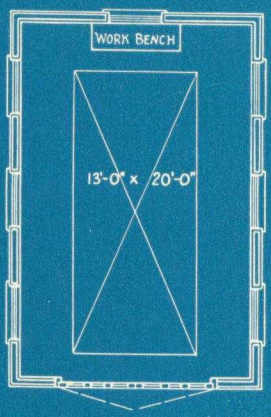
BILL OF MATERIALS FOR CEMENT WORK

ALPHA Cement	33 barrels
Sand	11 cu. yds.
Stone	20 cu. yds.
¼" reinforcing rods	1200 lin. ft.
½" reinforcing rods	50 lin. ft.

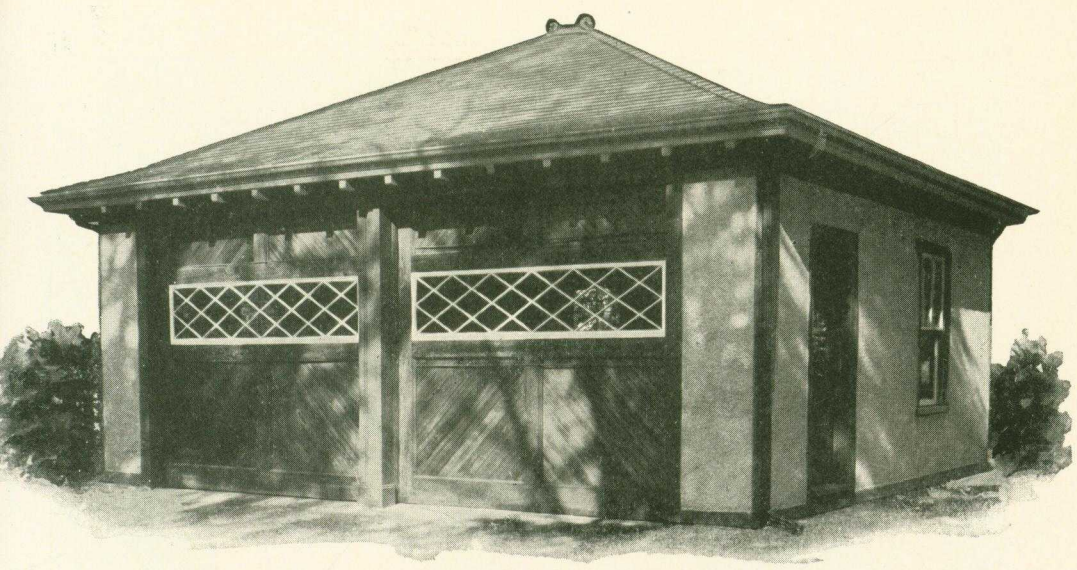
· FRONT ELEVATION ·



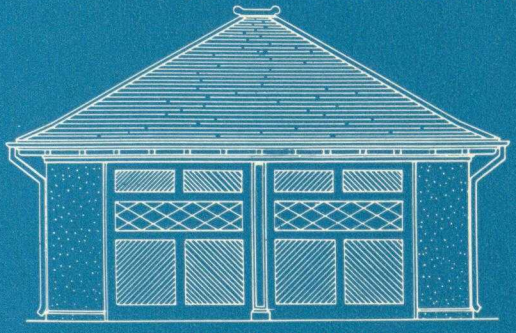
· SIDE ELEVATION ·



· PLAN ·



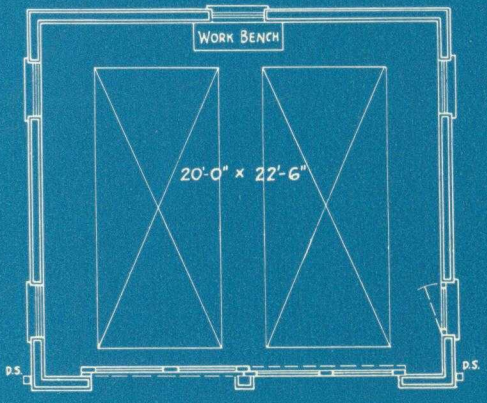
· AN ATTRACTIVE TYPE of TWO-CAR GARAGE ·



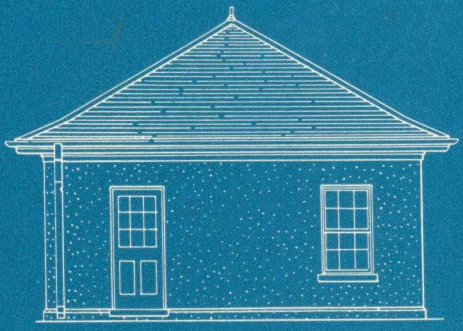
· FRONT ELEVATION ·

BILL OF MATERIALS FOR CEMENT WORK

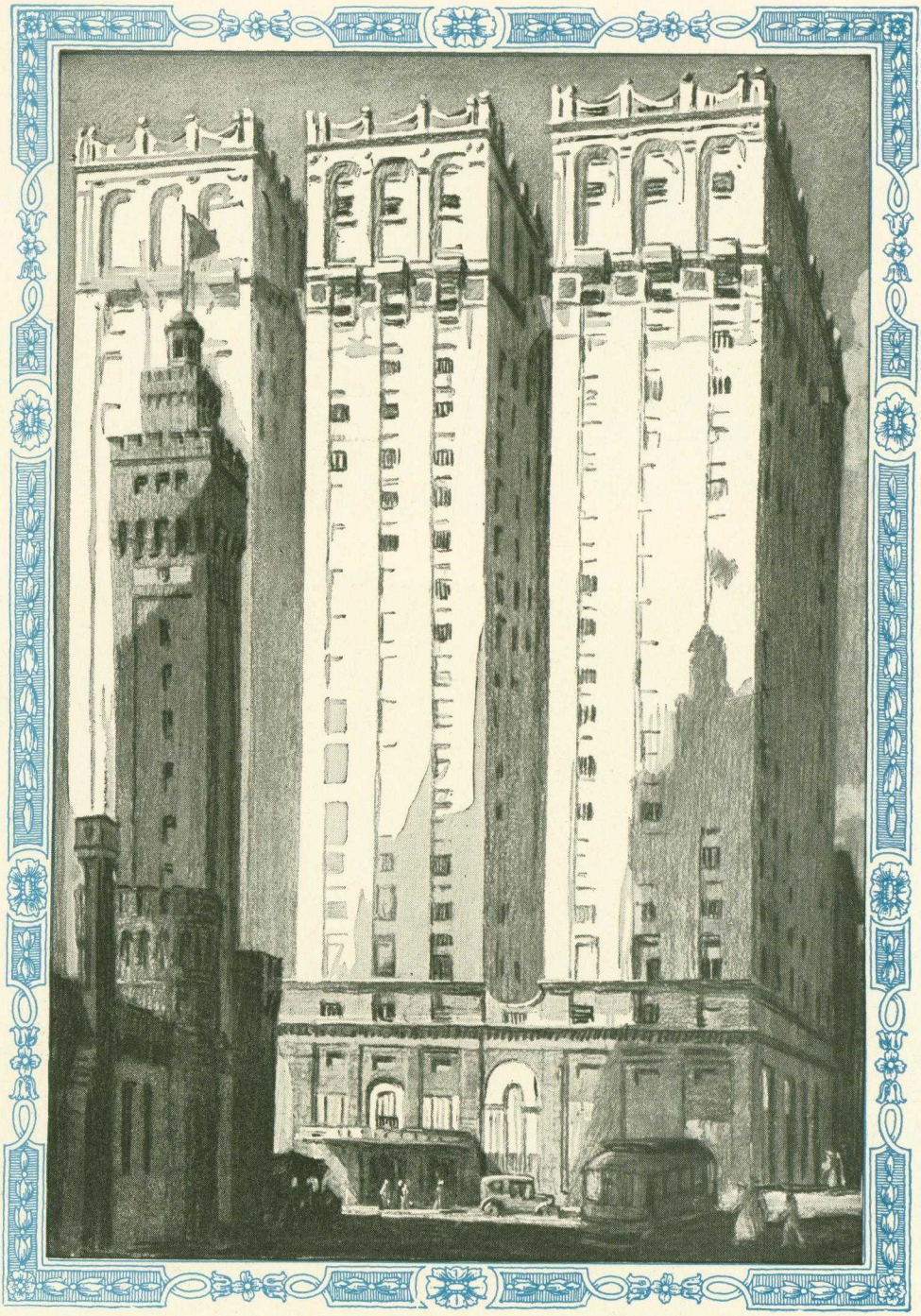
ALPHA Cement	38 barrels
Sand	13 cu. yds.
Stone	22 cu. yds.
¼" reinforcing rods	1200 lin. ft.
½" reinforcing rods	90 lin. ft.



· PLAN ·



· SIDE ELEVATION ·

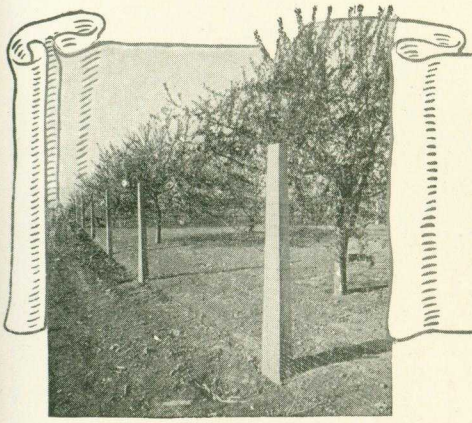


The Vanderbilt Hotel

(New York)

MODERN in every detail, this magnificent skyscraper hostelry dominates its section of the metropolis. Such are its fireproof qualities that a raging fire among unpacked furnishings was confined to the corridor of one floor and extinguished before many of its guests knew that there had been a fire.

Besides being absolutely firesafe, the Vanderbilt is permanent—built to last for all time. The materials used in its construction had to pass severe tests, applied by the engineers responsible for the work. That 60,000 bags of ALPHA CEMENT were used speaks well for the quality of the cement that is tested hourly by the chemists in the making.



Cement Posts

Fence Posts, Corner Posts, Gate Posts, Inclosure Walls

KEEPING fences in good condition is no easy task where the material in the post needs constant care and repair. Even the best wood posts will burn, rot, get out of line, break under heavy strains, or wash out in a flood.

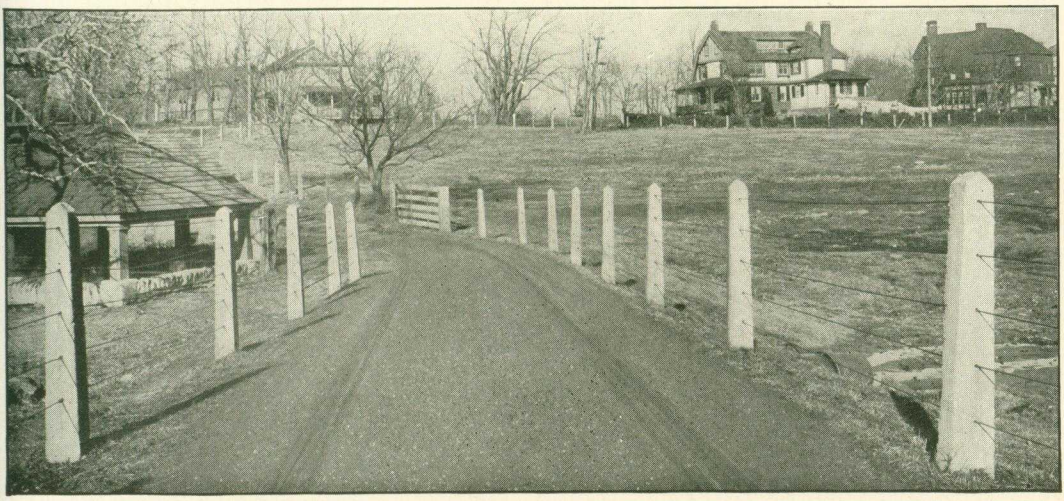
The cement fence post is everlasting. It keeps in alignment and can resist unusual strains without breaking. In some sections its first cost is no more than for a good wood post, but everywhere cement posts are cheaper in upkeep than wood posts. No repairs, no painting; they grow stronger each year.

In comparing the advantages of cement and wood fence posts, the U. S. Department of Agriculture, in Farmers' Bulletin No. 403, has this to say:

"After three years' service wooden posts possess only from one-third to one-half of their original strength, whereas concrete grows stronger with age and needs no repairs, for neither weather nor fire injures it.

"Cement posts are attractive in appearance because of their uniformity in size and color and, because of the durability, they effect a saving in giving greater life to the fencing material used, so that the permanent value of the property is increased."

The table on page 50, compiled by the U. S. Department of Agriculture, shows the average life of various kinds of fence posts. Note that cement fence posts last nearly twenty years longer than the best wooden posts. The cost does not greatly exceed the better grade of wooden post.



Cement fence posts on farm of Haverford College, Haverford, Pa. Made with ALPHA CEMENT

CONSTRUCTION · OF · AND ·

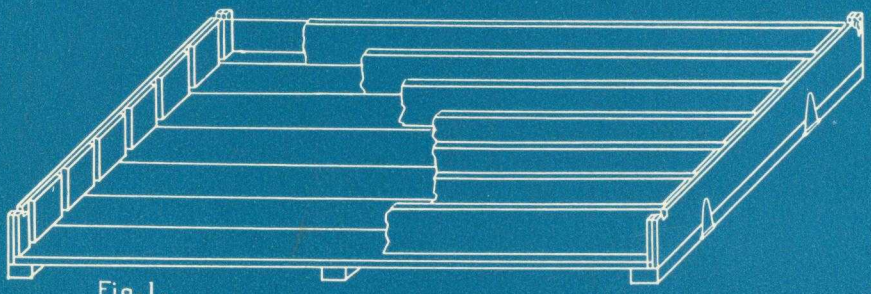


Fig. 1.
Gang mold for Concrete fence posts without taper

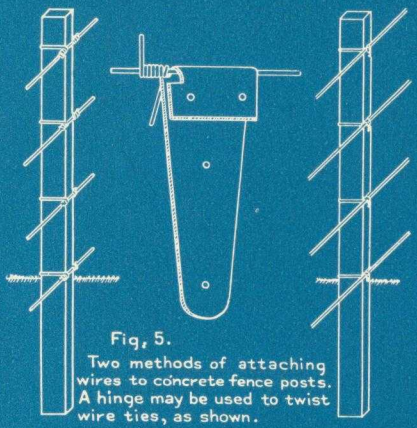


Fig. 5.
Two methods of attaching wires to concrete fence posts. A hinge may be used to twist wire ties, as shown.

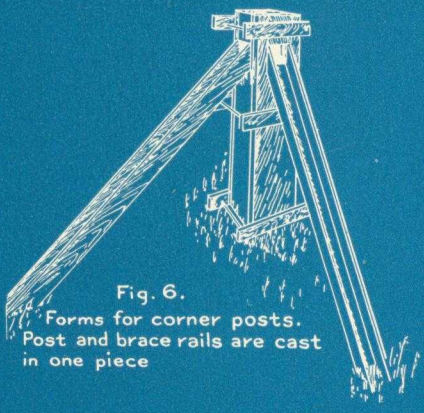


Fig. 6.
Forms for corner posts. Post and brace rails are cast in one piece

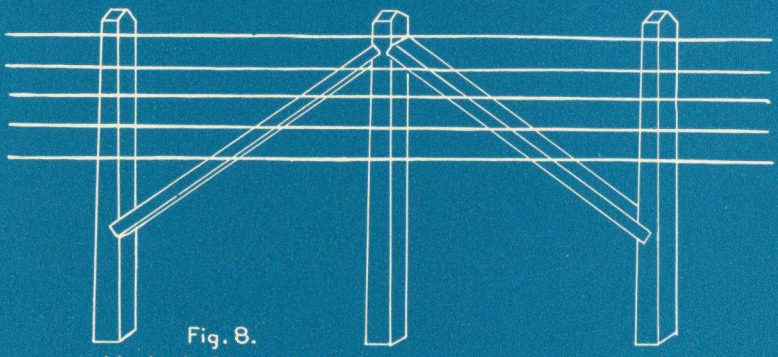


Fig. 8.
Method of bracing fence line every thirty posts. Principle is same as in Fig. 7.

CONCRETE · POSTS · INCLOSURE · WALLS ·

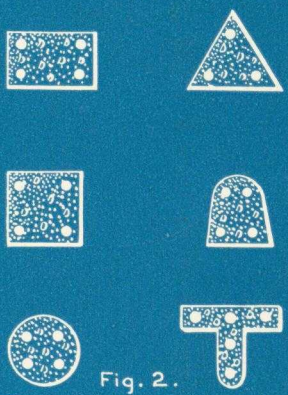


Fig. 2.
Proper position for reinforcing rods in various types of concrete fence posts

Fig. 3.
Wire spacer used for holding reinforcing rods in place.

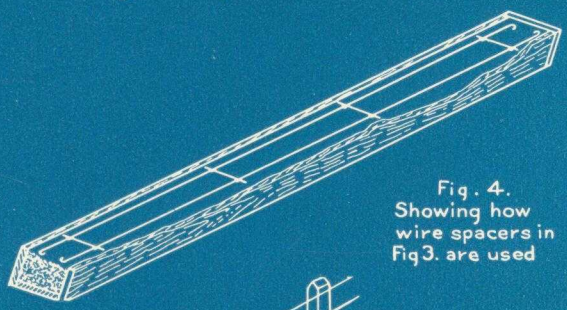


Fig. 4.
Showing how wire spacers in Fig 3. are used

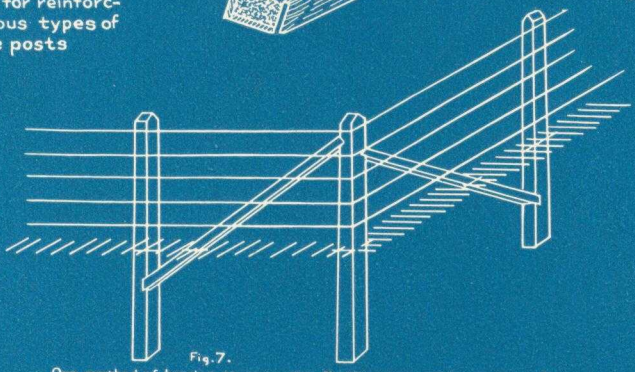


Fig. 7.
One method of bracing corner posts. Mortises are cast in corner and brace posts. Concrete brace rails are inserted in mortises as shown.

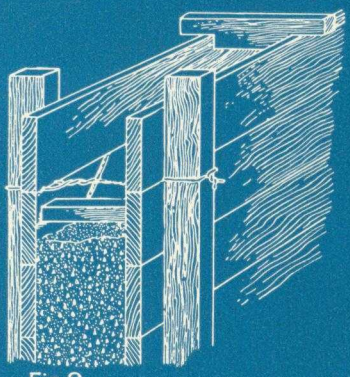


Fig 9.
A common method of spacing and tying forms for cocrete walls.

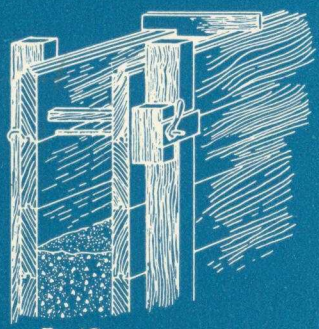
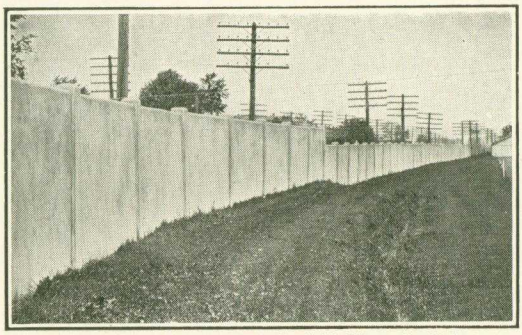


Fig. 10.
The rod and clamp method of holding wall forms in place



Cement wall around athletic field, Newark, Del.

KIND OF POST	Average Life	
	Number Estimated	Years
Osage Orange	789	29.9
Locust	464	23.8
Red Cedar	557	20.5
Mulberry	88	17.4
Catalpa	48	15.5
Bur Oak	97	15.3
Chestnut	94	14.8
White Cedar	1749	14.3
Walnut	60	11.5
White Oak	1242	11.4
Pine	41	11.2
Tamarack	67	10.5
Cherry	9	10.3
Hemlock	10	9.1
Sassafras	19	8.9
Elm	15	8.8
Ash	69	8.6
Red Oak	22	7.0
Willow	41	6.2
Cement	42	48.0
Stone	11	36.3
Steel	131	29.9

Molds for Cement Posts

The size of cement posts must be governed by individual requirements, by the character of the soil, and by probable strains they must stand. For ordinary fencing, no post should be smaller than 3 inches square at the top, 4½ inches square at the bottom and seven feet long.

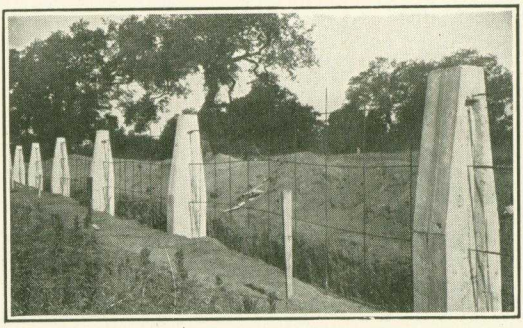
In fences, three types of posts are generally used: line-posts, bracing-posts and corner-posts; ranging in the order mentioned from average to heavy weight.

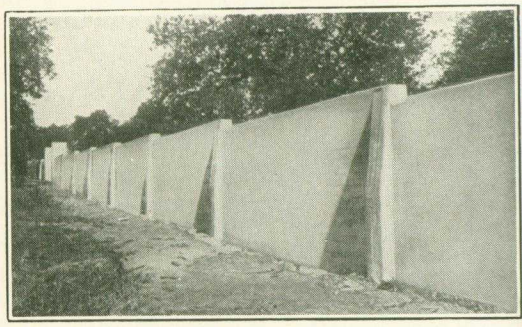
Cement line posts vary. Besides triangular posts, rectangular posts can be had tapering on two sides, or on four sides, or without taper. Molds for this last named type are easiest and cheapest to make, because they can be constructed in "gangs" or "sets" with continuous bottoms and end pieces. Such molds can be made at home, or patent steel molds may be bought. If a number of neighbors club together it would make the cost of molds very reasonable and the construction of posts quick and easy.

Reinforcing Cement Posts

Concrete is strong but quite inelastic. It is best therefore to combine the strength of concrete with the elasticity of steel by imbedding steel rods in the concrete.

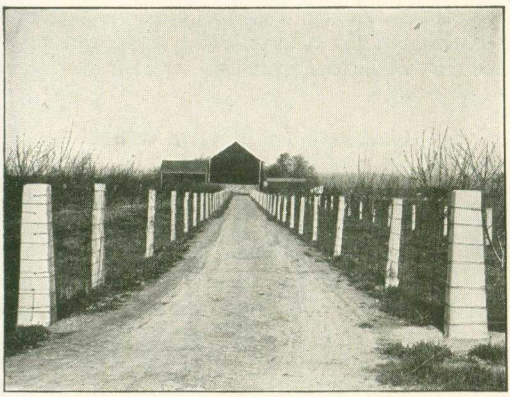
Since strains on a post may come from any direction, it is necessary to distribute the reinforcing to all sides of the post as indicated on the preceding page. One big rod in the center will not do. The size of rods depends upon the size of the post. Ordinary $\frac{3}{16}$-inch to $\frac{5}{16}$-inch diameter rods will suffice. Wire of proper size may be used but rods are more economical. They must always run the full length of the post, extending as far down in the ground as the post goes. To hold reinforcing rods in place while concrete is being placed, wire



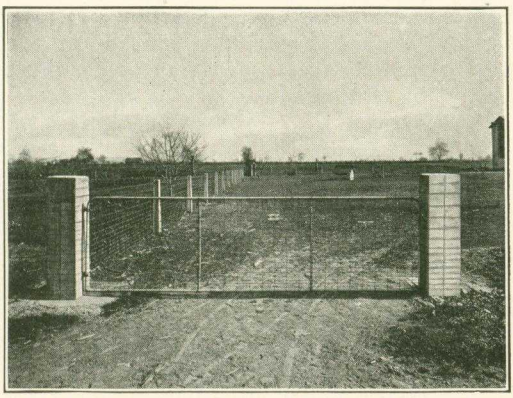


Cement wall built by erecting posts and reinforcing rods first, and then filling in sections between posts. If posts are equally spaced, two sets of wall forms are sufficient—one set being used while the other remains in place to let concrete harden

(Photos from American Thresherman and Farm Power)



Cement corner posts add years to the life of wood fence posts



Cement posts prevent gates from sagging

spacers are used. These spacers are of No. 16 wire twisted as shown in Fig. 3 on page 49, and used as shown in Fig. 4. Three or four spacers are used to a rod. Note, too, that the ends of rods are turned back about an inch.

Molding Cement Posts

Molds should be treated as suggested on page 20. Concrete for posts should be mixed only in quantities enough for immediate use, following directions on pages 9 to 19. No concrete that has stood for thirty minutes after mixing, should be used.

After the molds are filled to a depth of ¾-inch to 1-inch, two reinforcement rods, properly placed, are laid in. The molds are then filled to within ¾-inch to 1-inch of the top, when the remaining reinforcing is placed. They are then filled to the top.

As soon as the molds are filled, they should be tapped or moved up and down quickly from the corners. This will release the air bubbles and make the concrete more compact.

The exposed corners of the post may be bevelled off with an edger and the open face given a smooth finish with a trowel immediately after the surface water has been absorbed and before the concrete has become too hard.

Curing Cement Posts

After being placed concrete should be left in the mold two or three days to harden. When the end pieces and partitions of the mold are removed, the posts should be left on the bottom board in the shade for a week or ten days, and protected as suggested on page 19. After ten days, posts may be moved outdoors and piled as wood posts are piled. They should be handled with great care, as a slight drop may break a fresh post. Jarring may cause cracks, invisible at first, but seriously weakening.

Cement posts may be used when thirty days old, but not sooner. Concrete gains strength during the first year.

Attaching Wires. There are several ways of attaching wire to posts. Fig. 5 in the blueprint, as well as the illustration at the left, above, shows this.

Cement Corner Posts. Corner posts stand heavier strains than line posts, and should therefore be braced properly. They are generally made from 6-in. x 6-in. to 12-in. x 12-in. square without taper. The exact size is determined by particular needs. Reinforcing rods range from $\frac{9}{16}$-inch to 1-in.

On account of their weight and consequent inconvenience in handling, posts larger than 8 inches square are generally cast in place. A hole dug in the ground is filled to the ground level with concrete. Forms are put in position and filled with concrete. If the ground is not firm, forms should be set below as well as above ground.

In corner posts like that in Fig. 6 on the blueprint, the large base of underground part is built of concrete made with field stones in assorted sizes. Unless corner posts are so massive that they will

stand in their own weight, they must be braced. (See Figs. 6, 7 and 8 on the blueprint.) Braces as well as posts, must always be reinforced.

Posts may be made monolithic with braces, or posts may be notched or mortised about 8 inches from the top on the sides where the bracing is necessary. Brace rails are cast in molds. One end of the brace rail is inserted in the notch of the post, and the other end inserted in a similar notch near the bottom of a brace post. (See Fig. 7 on the blueprint.) A brace post is heavier than an ordinary line post.

In a fence it is well to brace about every thirtieth post. To do this it is necessary that the thirtieth post, and the post on each side of it, be a little heavier than the rest in order to support the brace rails.

Gate posts and hitching posts are made in the same manner as corner posts. Holes for bolt hinges are sometimes made by inserting a piece of gas pipe in the fresh concrete. Sometimes a hinge with a clamp strap that entirely encircles the post is used. Gate post should be braced unless they are made massive enough to withstand the strains. There is no limit to the many artistic effects possible to secure with concrete in the making of gate posts.

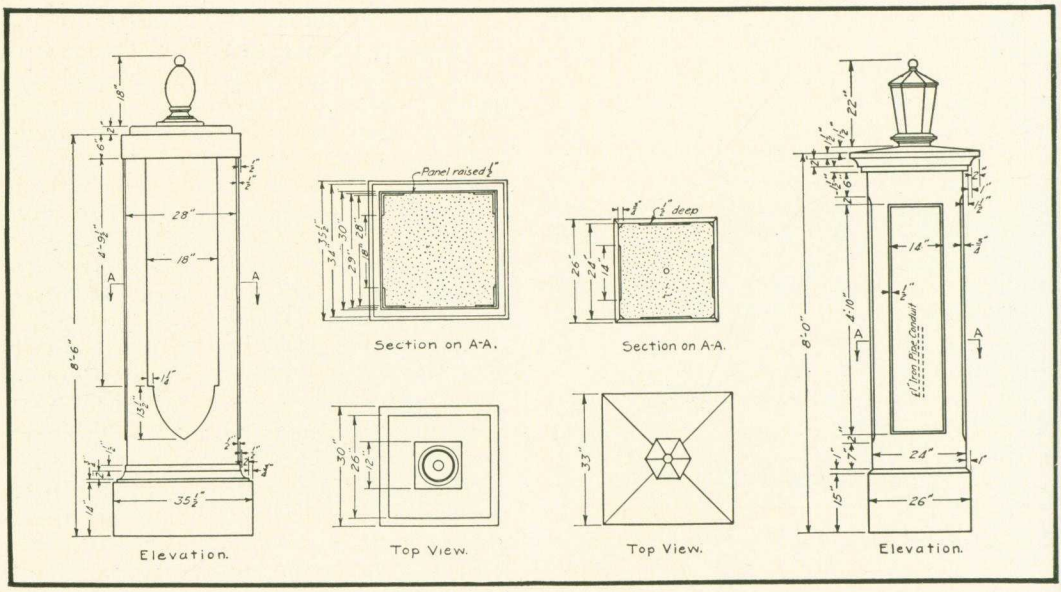
Cement Inclosure Walls

Cement walls are more attractive and more lasting than any other inclosure wall. They need no repairing or painting and are therefore economical.

The principles of construction are very much like those for house walls (see pages 20 and 22). An excavation deep enough to carry the foundation below the frost line is filled with a 6-or 8-inch layer of broken stone, cinders or brickbats, and then filled to the ground level with concrete.

Forms should be of one-inch material, well braced with 2 x 4 studs set closely enough together to prevent the bulging of form boards when the concrete is placed. While the concrete is being poured the forms are held securely in place by means of wire ties, bolts, wooden strips, etc. (See Figs. 9 and 10 in the blue-print.)

Reinforcing in cement walls should be placed near the center of the wall. Usually reinforcing rods in such walls run horizontally, but both vertical and horizontal may be used, as shown on page 50.



Good design for cement gate post

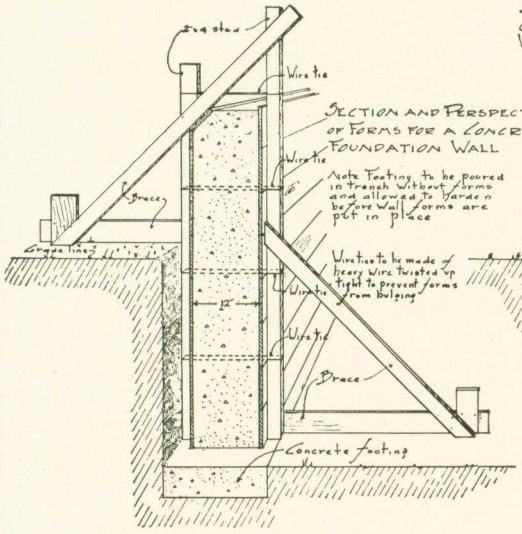

2x4 stud
Wire tie
SECTION AND PERSPECTIVE OF FORMS FOR A CONCRETE FOUNDATION WALL
Wire tie
Note Footing to be poured in trench without forms and allowed to harden before wall forms are put in place
Brace
Grade line
Wire ties to be made of heavy wire twisted up tight to prevent forms from bulging
12"
Wire tie
Wire tie
Brace
Concrete footing

Fig. 1

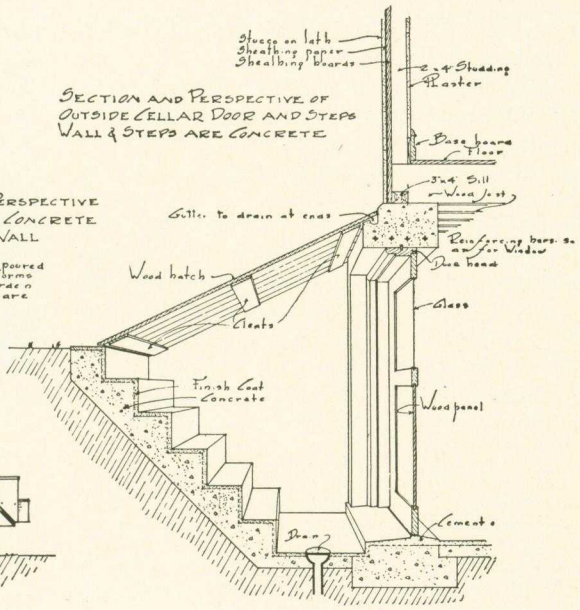


Fig. 2

Foundations, Walls and Steps

Fig. 1 illustrates in section and perspective forms for a cement foundation wall. It will be seen that the footing has been placed in the trench without forms and forms for the wall set up on the footing after the concrete has become firm. In order to provide a good bond between footing and the wall proper, it is well to leave the surface of the footing quite rough, in fact better bond can be secured by partly embedding in the upper surface of the footing rough field stones so that when concrete for the wall is placed bond can be secured with these stones. The text in this book under the heading of "Forms and Reinforcement" gives a number of excellent ideas on foundations.

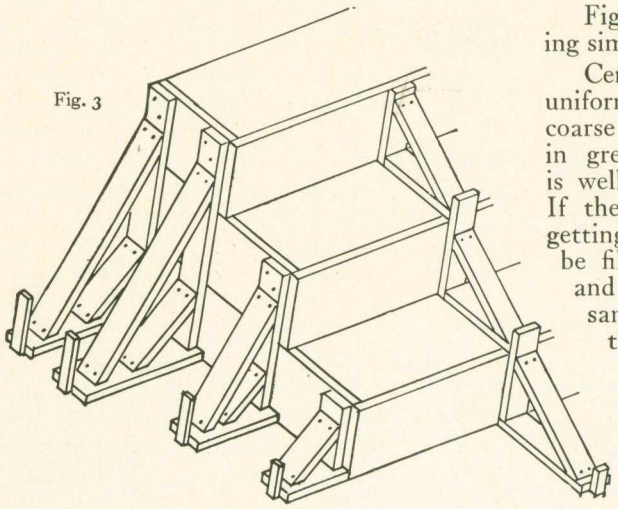
Foundations Under Old Buildings. A complete cement foundation can readily be built under an old building. All that is necessary is to remove from the old wall a few of the stones or bricks as the case may be, at various points around the foundation and insert short pieces of heavy timber to wedge up the building. The building should be carefully raised in this manner entirely clear of the old foundation. Then all of the old foundation should be removed and a trench dug and forms set in place in the usual manner for concreting. In case of small buildings it is usually easy to raise them high enough to allow working room, in which case the forms can be filled right up to the top with concrete. If the building is large and too heavy to be raised readily so as to provide necessary working headroom, the foundations may be made 3 inches wider than the sill. When the forms have been carried to the desired height the concrete may be inserted through this extra space of 3 inches. To make placing of the first layers of concrete easy the top board of the forms may be left off until ready to place the last layer of concrete. The building should not be lowered upon the foundation until the concrete has had at least two weeks to harden. After this time the timbers used for the purpose of wedging up the building may be removed and the openings which they occupied be filled with concrete.

Cellar Steps are shown with construction detail in Fig. 2. While side retaining walls may be built before or after cellar steps are constructed, it will usually be found more convenient to place the

forms for the steps after the side walls have been built.

Before laying the concrete for the steps the slope on which they are to rest must be well compacted so that there will be no settlement and consequent cracking of the concrete. If there is any doubt as to the sustaining power of the soil it would be well to lay a 2-inch layer of concrete first on this slope and then to embed in

Fig. 3



Construction of forms for cement steps, showing proper method of bracing

it ¼-inch rods placed 12 inches center to center, after which concreting of the steps may be continued. This reinforcing will serve to prevent cracking at the relatively thin section of the concrete where the tread and the rise meet.

Retaining Wall and Steps

Terraces if too steep, will not stay sodded, and if too flat take up room which would otherwise be a part of the lawn. The neatest way is to place a retaining wall along the terrace edge.

If the wall is over 1 foot high steps are necessary. A most convenient arrangement is to have the bottom step come flush with the face of the wall, making it impossible to fall over one or two projecting steps in the dark.

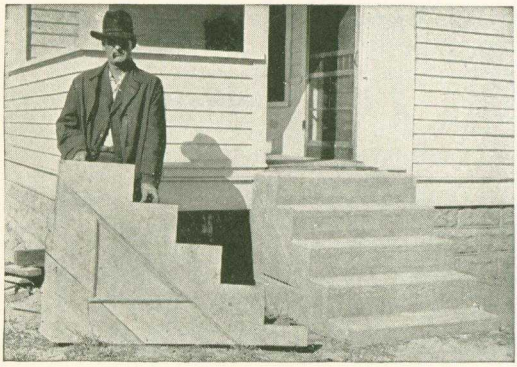
In building, insert a stop plank between the front and back forms to prevent the concrete from going to the full height of the wall. The bottom of this plank should be kept at a height above the bottom of the wall sufficient to form the first step.

After the concrete for the wall is placed, remove the section of the form where the steps are to come, and dig out the earth to a depth sufficient to hold them. The remaining steps are built in the manner already described.

Fig. 3 gives suggestions for constructing simple forms for outside steps.

Cement steps can readily be built of a uniform concrete throughout provided the coarse aggregate does not exceed ¾ inch in greatest dimension, and the concrete is well spaded when placed in the forms. If there is any difficulty encountered in getting a good surface finish, forms may be filled to within about ½ inch of full and a 1:2 cement mortar in which the sand is coarse and hard be used to fill the remainder of the forms. This finishing coat should be placed immediately after placing the other concrete so as to secure a good bond between base and wearing surface. If any irregularities appear in the face of the risers of the steps after forms are removed, these can be readily pointed up with a 1:2 cement mortar and be finally given a coat of cement grout paint if a smoother finish is desired, this being gone over with a trowel just as soon as the grout has commenced to harden.

The illustration below is a suggestion of how individuality can be attained.



Side form for steps, showing how a little decorative line can be easily introduced

The entrance of this trim looking cement storage cellar may be planned by the method shown at top of page 53

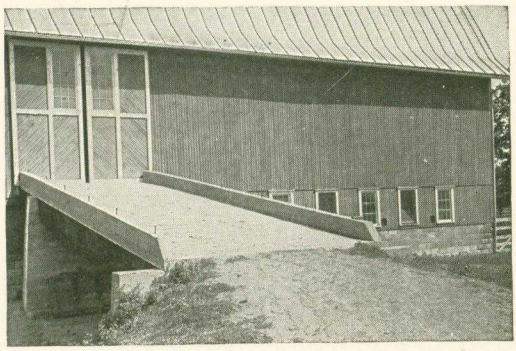
Cement Block in Foundations and Walls. For large structures and particularly where it is desired that the foundation or wall be of massive character, no doubt monolithic construction is to be preferred, but for a great deal of foundation work, particularly that type appropriate for dwelling houses and other small buildings, cement block may be and often are used to advantage. Where cement block are available, the labor and expense of setting up and taking down forms is eliminated and the resulting cement work is just as satisfactory in every way as though monolithic cement construction were used.

The laying of cement block being essentially masonry work, comparable to the laying of brick and dimension stone, a few precautions different from those one would call attention to in connection with monolithic construction are necessary when cement block are used for building foundations. It is always desirable that basements be dry and there is no reason why basements enclosed by cement block foundation walls cannot be made and kept just as dry as though the enclosure wall were of monolithic construction. All that is necessary is to make sure that the block used are of good dense mixture and that they are laid in a rich sand cement mortar not leaner than 1:3, that the block are well wetted before laying and that the mortar joints are completely filled with mortar and well pointed up. As an extra precaution the exterior of the finished wall may be given a thin plaster coat of 1:2 cement sand mortar or it may be mopped with a substantial coat of hot tar.

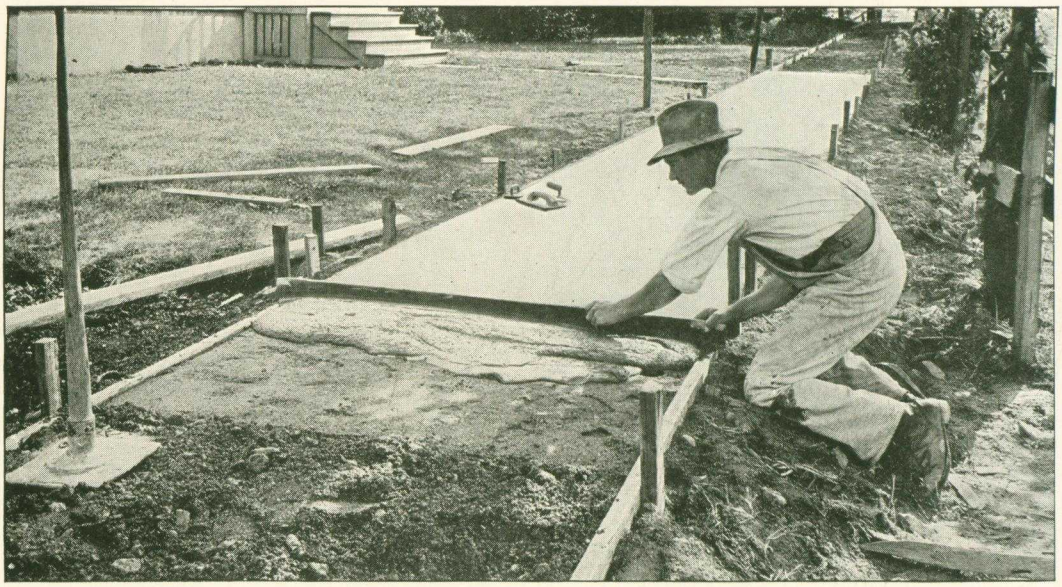
Walks and Floors

So far as the operations of construction go, there is little difference between cement walks and cement floors laid on the ground. Cement floors such as laid for the various stories of a building above ground level, are necessarily reinforced and, therefore, involve the observance of some principles of construction not associated with similar work supported by soil foundation. The following discussion is not intended to in any way consider the building of reinforced cement floors.

A cement walk is a stretch or strip of concrete intended primarily for pedestrian traffic. It may, however, be compared to any cement pavement. The first essential to success in the building of walks and of floors on soil foundation is that the soil shall be well drained so as to prevent water from being retained beneath, thus preventing the upheaval in freezing weather. The area on which the concrete is to be laid should be cleaned from all vegetation and similar refuse, and if the soil is not firm so as to provide a substantial foundation, it should be thoroughly compacted by rolling or tamping so that everywhere bearing power will be equal. All soft or spongy spots should be dug out and filled with clean gravel containing little or no sand or with hard cinders free from ash, and such filling should be well compacted. It is desirable, however, to avoid the use of any such filling material where effective drainage in the natural soil can be secured because



Good type of barn driveway. By adding side walls and a cement floor an excellent cold-storage room could be had



Leveling surface of sidewalk by use of straight-edge

the tendency is, when using a subbase of gravel or cinders to place it in what amounts to a trench and in that way provide a "sink" or sump hole which serves not to drain the foundation but to actually cause water to collect and be retained beneath the finished pavement. Therefore, if a subbase of cinders or gravel is used the added precaution should be taken to lay tile drains to lower outlets at such intervals as will secure free drainage of the subbase.

In order that the surface of a walk or floor may drain quickly after rains, it is necessary that the surface have a slight gradient or slope in one direction or as is sometimes done in the case of a walk, have the surface very slightly crowned. One-quarter of an inch to the foot is sufficient slope to provide for a floor and not to exceed one-quarter inch crown at the center of a walk of usual width (4 feet) will provide all necessary drainage slope for its surface.

Outdoor floors and cement walks may be either of one or two-course construction. For feeding floors, barnyard pavements, driveways and ordinary walks around the farm, one-course construction is preferred. For such work a 1:2½:5 concrete may be used. In the case of feeding floors or barnyard pavements where greater density and hence, dampness or penetration of filth is to be prevented, a 1:2:3 mixture is preferred.

Generally speaking, no sidewalk should be less than 5 inches thick. The same may be said of floors, except if the latter are to be used in part as driveways and, therefore, will be subjected to the weight of heavy traffic, the thickness should be greater and in most cases reinforcement in the concrete will be desirable.

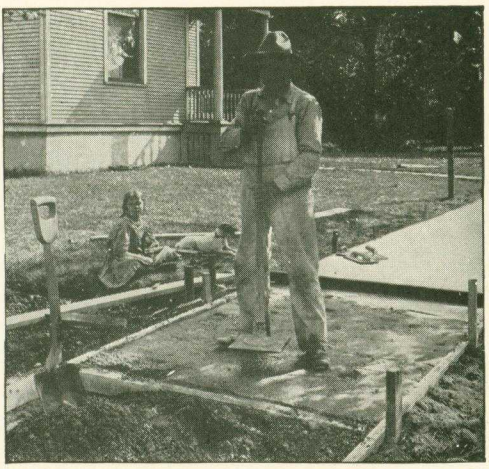
Depending on the thickness of the pavement, 2 by 4's or 2 by 6's will serve for forms. These should be held rigidly in place by stakes or braces with top edges true to the line and grade required. Where sidewalks fill the space between curb and building lines, forms should be so set as to give the walk a slope toward the curb of ¼-inch per foot of width. Where walks are bordered by lawns, forms should be set level and drainage of the walk secured by suitable crown at the center. One-quarter inch for each foot from side to center is the maximum necessary. Walks and outdoor floors may be built by so setting forms that alternate slabs are concreted first and when these have sufficiently hardened forms can be removed to permit concreting of intermediate slabs.

Present-day practice in building walks has, however, run toward continuous con-

creting of the strips and joints are provided for by division plates used where desired to mark the limitation of slabs or by cutting through the entire thickness after it has sufficiently hardened so each slab may be completely separated from adjoining ones. Where division plates are used, they are usually of ⅛-inch thick steel as wide as the depth of the slab and as long as the width of the walk. They should be thoroughly cleaned and oiled each time before and after use. After the concrete has hardened sufficiently to prevent breaking, the division plate can be removed without difficulty.

Concrete is usually mixed to a rather stiff consistency that will require rather vigorous working to bring to proper surface. After placed between forms it is struck off to the required level by using a template or straight edge. The subgrade where concrete is laid should be dampened just before concrete is placed upon it. If dividing plates are not used to mark the limitations in slabs, every care must be taken to see that in cutting through the concrete to mark a joint it is completely cut through so that slabs are separate. The surface edge of each slab should be rounded to a radius of ¼-inch by using one of the common finishing tools intended for that purpose.

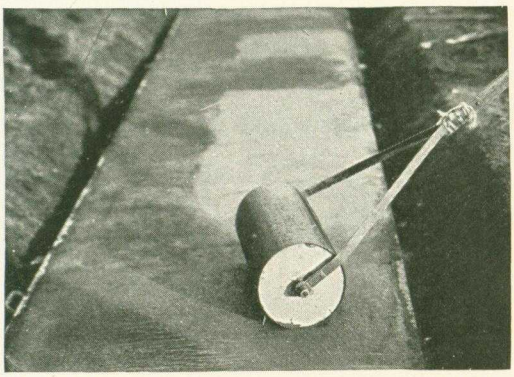
In walks, expansion joints should be used to take care of changing volume of the concrete due to temperature changes. Expansion joints should extend from the surface to the subgrade, be truly at right angles to the sidewalk surface, and be made by putting the specified joint filler in place before placing the concrete. The joint filler used in such cases is generally a pre-



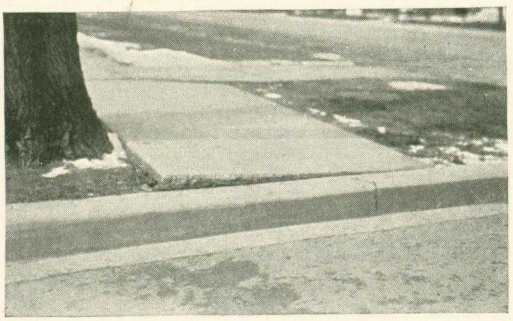
Tamping the base in sidewalk construction

molded asphaltic preparation similar to that used in joints in other cement pavements such as roads and streets. The expansion joints should be placed at approximately 50-foot intervals and should be about ½-inch thick.

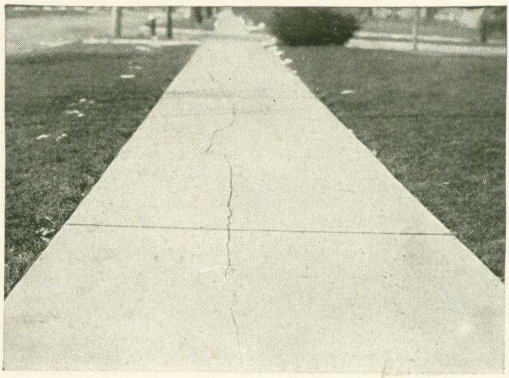
No other detail of cement pavement construction is of more importance than proper curing of the work after actual concreting is finished. In the case of cement walks, however, this precaution for some unaccountable reason is almost universally neglected. As a result sun and wind dry out water from the concrete before that water has had a chance to perform one of its principal objects, namely, the chemical transformation of the cement which results in thorough hardening of the concrete. Specifications for cement highway pavements require that a covering of earth or some other moisture-retaining



Use of roller in finishing one-course sidewalk construction



An example of failure to provide for tree growth, resulting in upheaval of slab. A semicircle should have been left in the slab when laid



Improper drainage is sometimes the cause of cracking of walks at the center. Often, however, such cracking is due to the area on which the concrete is laid being slightly higher at the center than at the sides; that is, compacted more at the center than at the sides, with the result that the slab rests on this hard center and lacks support at the sides

covering be placed on the pavement as soon as practicable to do so after having placed the last concrete and further require that such covering shall be kept in place and moist for varying periods in order to enable the concrete to thoroughly and uniformly harden.

If the construction is to be two-course work, then a base consisting of 4½ inches of 1:3:5 concrete may be used with a finishing coat of ¾-inch mixture of a 1:2 cement mortar. It is necessary that the fine aggregate used in the wearing course mixture shall be hard and durable in order to resist the wear of traffic.

The latest practice in cement walk construction follows a practice in highway pavement construction that has become general in the past two or three years, namely, the use of a light roller to compact the concrete immediately after it has been struck off in the forms and before the final finish is given by a wood hand float or trowel. It is recommended that a roller for this purpose be from 10 to 12 inches in diameter and so built that its weight is approximately one pound per linear inch of surface contact.

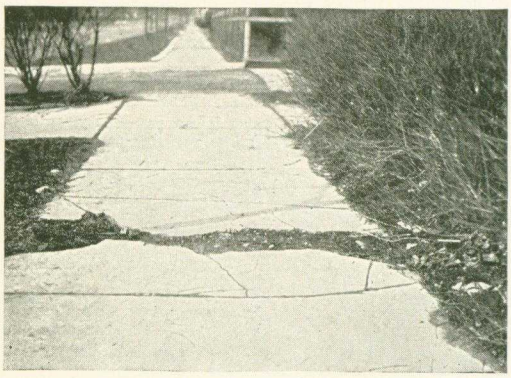
Generally speaking, cement walks should consist of slabs not greater than 6 feet long in any dimension. Indoor floors such as those used in barns and stables should be laid in slabs not greater than 10 feet in any one dimension unless the concrete is reinforced.

"Dusting" of Floors. Frequently we hear complaints of cement floors dusting badly. The cause of this has been definitely fixed in the use of too fine or dirty sand, soft sand, too lean a mixture, coarse aggregate coated with dust or clay, dirty material of any sort, too much troweling when finishing with a steel trowel, having the cement mixture too dry or too wet and neglecting to protect the work after finished.

Knowing the causes of dusting the remedy is evident, namely, be sure to avoid those bad practices known to contribute to the undesirable end.

Curbs and Driveways

To build a fine cement walk or driveway without protecting the edges with curbing would mean the formation of irregular and disfiguring gutters established by nature, if not the undermining of the structure. The additional expense of adding curbing while the work is under way would represent a small outlay compared with its value. It is a simple matter to construct substantial cement curbing. When properly done it will not get out of alignment as is the case with stone curbing. It may be brought to an exact line and finish, thus corresponding in texture and appearance to the thing it protects.



In two-course work the top is frequently not laid soon enough following the placing of the base, with the result that sooner or later the top course scales or breaks away from the base. Frequently the top course is too thin and also, as mentioned in the accompanying text, the base often contains so little cement as to have no excuse for being called concrete

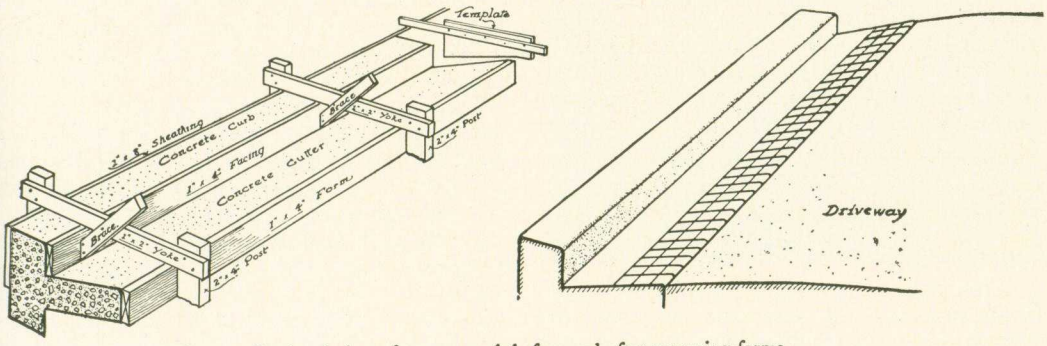
Cement construction is used for this purpose in all large cities and towns, and in response to the great demand for curbing of this character, machinery has been invented to facilitate construction. The same good results, however, may be secured where the work is done by hand. A standard method of constructing ordinary curbing, such as would be suitable for the farm or a suburban property, might be described as follows:

At the edge of the pavement, and measuring from its finished surface, dig a trench 12 inches deep and at least 6 inches wide. Place over this the forms, the bottom of the forms being on a level with the finished surface of the road. Make the forms about 6 inches high. The forms should be placed both back and front of the proposed curb, the front form having a batter or incline of ½ inch. Concrete should then be deposited in the ditch and within the forms, and the upper surface smoothed off with a steel float and all small surface interstices filled in with a 1:1 mortar in case this is necessary. The upper edge should be rounded with a 1-inch rounding tool so as to give a neater appearance. The moment the concrete is sufficiently hard not to pit under sprinkling, this should begin and the concrete should be kept wet for at least two days. The more frequent and prolonged the sprinkling of the newly-finished work, the better the results.

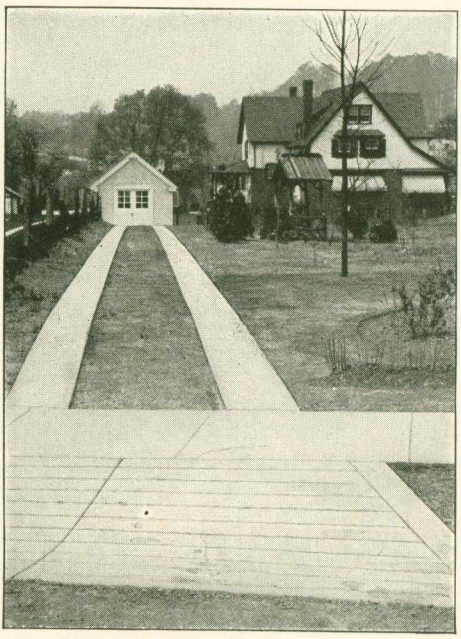
Cement Driveways

The cement driveway is reasonable in first cost, and if well built, will last indefinitely. Even on highways subject to constant traffic of all descriptions, cement has proved to be more satisfactory than any other material of like cost. For example, a cement road put down in Bellefontaine, Ohio, more than twenty years ago has cost less than $25 per mile per year for maintenance during that long period of time. On a private driveway of concrete up-keep cost should be practically negligible. It is in recognition of its durable and economical properties that many owners of large country estates are substituting cement construction for macadam and other types of roads.

In building a driveway to a house to provide for private automobile or service traffic which is seldom excessive, lay the concrete 5 inches at the sides and 6 inches at the center. This thickness will be amply sufficient for such infrequent traffic. The proportions should be 1:2:4. The concrete should be mixed to a mushy consistency and when in place between side forms, which should be rigidly staked at each side of the road, proper shape should be given to the road by means of a template, a long plank reaching from side form to side form, and cut to the desired crown. After bringing the road to proper contour by the use of the template the surface should be evened up by lightly troweling with a wooden float. When the concrete is sufficiently hard not to pit, the surface should be sprinkled with water, and when the concrete will stand the weight of a man, it should be covered with about 2 inches of earth, which should be kept wet for at least ten days. No traffic should be allowed upon the road for two weeks. Cut at every 25 or 30 feet what are known as expansion joints. These expansion joints should be filled with asphaltic felt or tar paper. Where the drive-



Sectional view of cement curb before and after removing forms



A method of saving concrete in an automobile runway

way receives very heavy loads, such as hay wagons and large trucks, make the concrete 6 inches at the side and 8 inches at the center, mixed in the proportions of 1:2:3. Otherwise the method of construction is the same as already described, with the exception that the edges of the joints should be protected by special steel plates.

Cement Tracks for Automobiles

In some cases property owners possessed of small lots have adopted a rather ingenious method of making cement roads for automobiles by digging trenches and establishing therein narrow cement tracks as shown in the accompanying illustration. This type of construction is not practicable where vehicles pass each other, and is intended solely for a private driveway with turf between the tracks and on both sides so as not to make it a conspicuous thoroughfare.

Small Cement Buildings

Strength, permanence and freedom from repairs and constant expense are just as much a part of small cement houses as large ones. Small cement buildings include chicken houses, icehouses, hog houses, machine sheds, smoke houses, garages, dairy buildings and other similar structures.

In a way, all well constructed buildings are built by following certain so-called "specifications," and except as it is necessary to vary certain details of a specification to provide for different foundations so that the weight of different sized buildings will be properly carried by the soil, one broad, general specification can be made to include most, if not all, of the requirements of construction. As regards cement work, such a specification is equally as applicable to the small milkhouse as to the large cement barn.

Foundations for Small Buildings. As soils have different bearing capacity, the first thing necessary is to excavate foundation trenches to such a depth that firm soil will be reached to provide the necessary load-carrying capacity, or in the absence of deep excavations for foundation trenches, to construct a footing so that the load to be carried will be distributed over a suitable area, thus preventing the settlement of the structure. It is also advisable, regardless of whether or not a footing is necessary, to begin the foundation sufficiently below ground level to prevent possible disturbance from frost penetration and the heaving that may result. This varies considerably, according to climate. All roots, sod and any other refuse material must be removed and all soft or spongy spots be excavated, and the holes filled with clean, well tamped material. Clean gravel or cinders are suitable for the purpose.

Sometimes it is necessary after footings have been completed and have thoroughly hardened and walls have been finished to ground level, to excavate inside the enclosure and provide a suitable subbase for a cement floor where such is to be part of the structure. Often the floor is constructed immediately after completing the foundation walls to ground level; otherwise, it is built after walls have been finished and the structure practically enclosed. In any event, on account of possibility of settlement, which undoubtedly would be unequal if it took

place, a joint should be provided all around the inside of the foundation wall so that the foundation and floor are separate.

Thickness of Walls. For the average run of small buildings walls need be no more than 6 inches thick. The foundation for a structure of such type should start on a cement footing 12 inches wide and 6 inches thick, 3 feet below ground level, in some cases deeper according to climate. On top of this there may be laid a 10-inch wall to ground level. As a matter of fact, a wall of lesser thickness would answer, but it is extremely difficult to excavate a narrower trench and place concrete in it without knocking down earth, so there is true economy of time and labor in building the thicker wall to ground level and continuing with a 6-inch wall from there on.

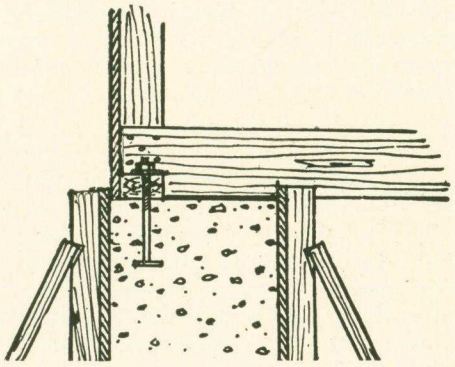
Proportions will be found in the Tables of Recommended Mixtures on pages 11 and 12.

When laying foundations upon which wooden structures are to be erected, it is always advisable to embed anchor bolts in the concrete so that the wood sill may be firmly anchored to the concrete. This in turn serves to anchor the whole building against possible destruction from heavy winds if the timbers are well framed into or fastened to the sills by stud anchors. Where sills are not used, such stud anchors are themselves attached to the cement foundation by bolts previously embedded in the concrete at the time the last few inches of the foundation is constructed. See illustration on this page. These bolts are held in the position desired while doing final filling of forms, by suspending them from hangers resting across from inside to outside forms.

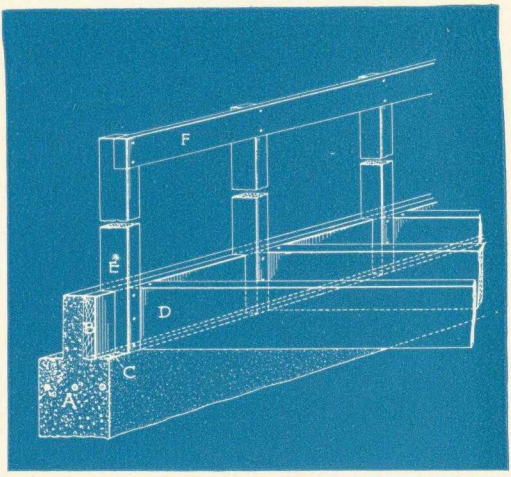
Roofs

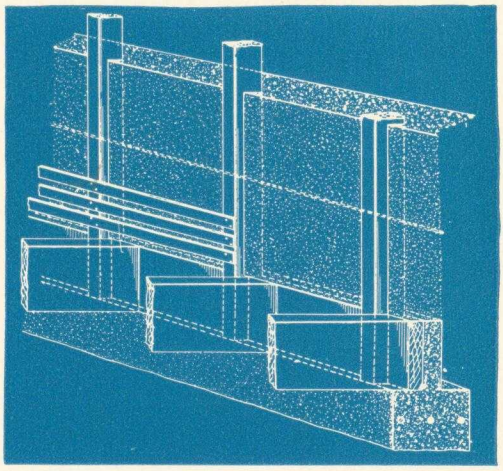
Cement roofs, like other cement structures, reduce fire risk by eliminating the hazard of fire. Reinforced monolithic and a plastered cement roof formed on a base or ground of metal fabric are used both for pitched and flat roofs. Usually the cement roof is designed after the slab type with but little pitch.

Fig. 5, page 22, is an example of a typical slab roof.



Method of inserting bolts in last few inches of cement foundation so that sills may be secured tightly





A good method used in wall construction of a cement house. The wooden studs are left embedded partly in the concrete. The slight interior projection of the studs makes furring and a dead-air space easily possible

A slab 3 inches thick is about the most convenient to place. Such slabs properly reinforced, are suited to a span not over 8 by 8 feet. If the span is greater than that, the thickness of slabs should be increased ½ inch for each additional 2 feet. The span represents the distance between the center line of walls.

The reinforcing for roofs of this type should be ⅜-inch round rods spaced 11 inches apart, center to center, where the roof is 8 by 8 feet, and 2¼ inches closer together for each additional 2 feet of span.

Forms for roofs should be so designed and braced when in place that they will not sag under the load of concrete they must sustain while the concrete is hardening. Without such precautions, progressive cracking while hardening will deprive the finished roof of strength and watertightness.

Forms should be left in place at least two weeks in favorable weather, and a month or more in cold weather in order to prevent possibility of collapse when removed.

Pebbles used should not exceed in size 1 inch. In some cases, especially in the thinner slabs where the reinforcing lies rather close to the bottom plane of the slab, a ¾-inch maximum size for pebbles would be better, since this will allow thorough placing of concrete under and around the reinforcing rods.

Cement Poultry Houses

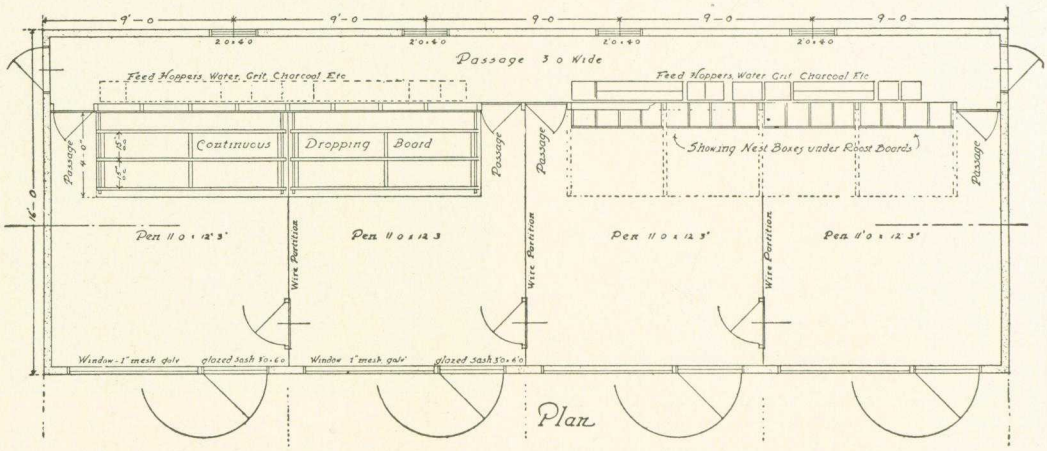
Hens can be made to produce large quantities of eggs and maintain such a production if they are provided with suitable quarters and are otherwise well cared for. Sanitation is a large part of success in poultry raising. Good cement construction in a poultry house will improve sanitation by checking vermin and other poultry pests.

Foundation requirements are included in the chapter on "Small Cement Buildings." (Page 60.)

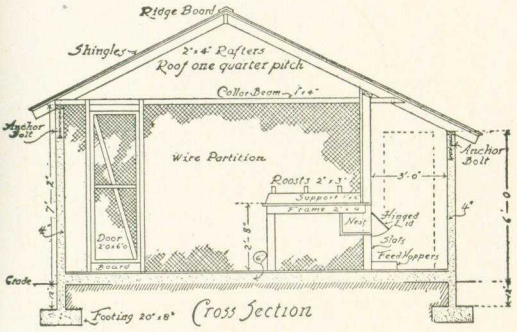
This design, which is for a cement poultry house 16 x 45 feet, may be halved if desired, without varying any of the construction requirements.

This poultry house plans ventilation from open windows covered with 1-inch poultry mesh and protected against extreme cold weather by muslin drop curtains. Dampness on walls of poultry houses can be avoided in the same way as in dairy barns. (See page 68.)

Cement poultry houses are rat-and mouse-proof. Where the poultry house floor must necessarily be located on soil which is not favored with the best of drainage, then it is well to prepare a subbase on which to lay the floor. This should be preferably 8 inches of well-tamped, clean gravel, or cinders free from ashes, and this subbase should be connected at several points to tile drains that will prevent water from remaining beneath the floor. The



Floor plan of well arranged cement poultry house



Section view of poultry house

floor should be of one-course construction, using a 1:2:3 mixture, and should be graded so that rain driving in will drain off. On this floor there can be thrown any kind of clean litter for the animals to scratch in.

Poultry house walls should be of a 1:2½:4 mixture, in which the coarse aggregate consists of material well graded from ¼ up to 1 inch maximum size, on account of the thin wall section. See the chapter on "Forms and Reinforcement." The poultry house design here shown calls for only a 4-inch wall. Carefully constructed, this will sustain the weight well. Nevertheless, in general practice it would be better to provide for a 6-inch wall.

Cement Icehouses

To the average farmer, an icehouse is convenient and profitable. To the dairy farmer it is necessary as well. The icehouse that holds and preserves ice sufficient to carry from one ice harvest to the next soon repays its cost in the savings made on ice. Idle days during the winter, put to harvesting and storing ice, bring the cost of ice very low.

Strange as it may seem, there is a fire-risk involved in the storage of ice.

Sawdust or hay or straw is used for packing and probably the variable content of moisture in these materials causes decomposition and consequent heating in a way similar to the heating in the decomposition of manure, and this frequently results in fire.

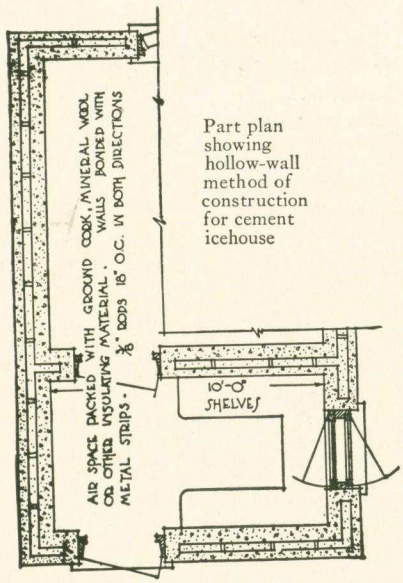
Wood is a poor material from the economic standpoint to use in icehouse construction. It is not fire-safe and soon rots out owing to the alternate wet and dry conditions to which exposed when the house is filled with ice, and from neglect when empty. No other material is so well adapted to icehouse construction as cement.

The accompanying drawings illustrate how the same structure may be built by either of two methods—first, with a single monolithic wall; second, with double monolithic walls, thus providing an air space which accomplishes the best kind of insulation and hence reduces to a minimum the melting of ice from outside temperature influences.

A number of modifications of the plan will suggest themselves to fit possible individual requirements. For instance, it is quite a simple matter to extend a cement constructed refrigerator compartment into the ice storage room so that this compartment will always be surrounded with ice and hence serve as an actual cold room for eggs, dressed poultry, milk and cream.

The foundation and walls follow the specifications in the chapter on "Foundations, Walls, etc." and reinforcement suggestions will be found on page 24.

The floor of cement construction slopes in all directions toward a central drain. This floor is made independent of the side walls and should be so laid that there will be a ½-inch joint all around which can be


AIR SPACE PACKED WITH GROUND CORK, MINERAL WOOL OR OTHER INSULATING MATERIAL.
WALLS BONDED WITH ⅜" RODS 18" O.C. IN BOTH DIRECTIONS
METAL STRIPS.
10'-0" SHELVES

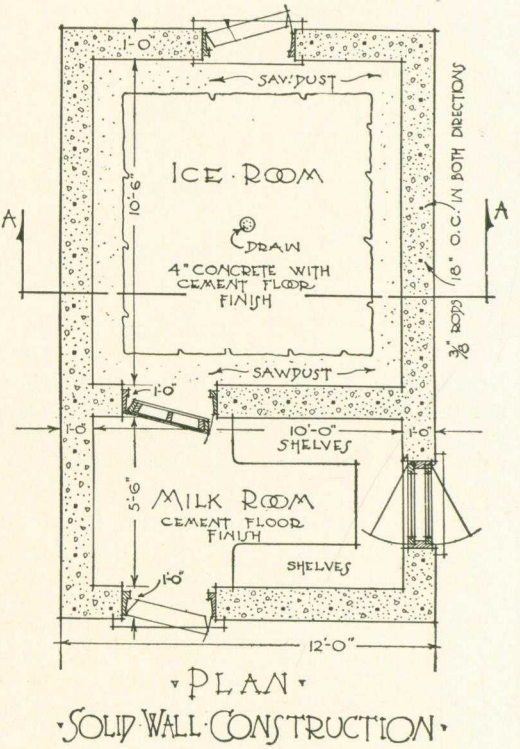
Part plan showing hollow-wall method of construction for cement icehouse

sealed against leakage and entrance of air, by pouring into it hot tar or asphalt. The drain is "trapped" so that the water from ice melting will seal it against the possible entrance of air, thus preventing rapid melting of ice.

The smallest practical dimensions for the farm icehouse should be considered as 10 x 10 x 10 feet, giving contents of 1000 cubic feet. Since a cubic foot of ice weighs about 57 pounds, such a house would hold about 20 tons allowing for the usual waste of space in packing ice.

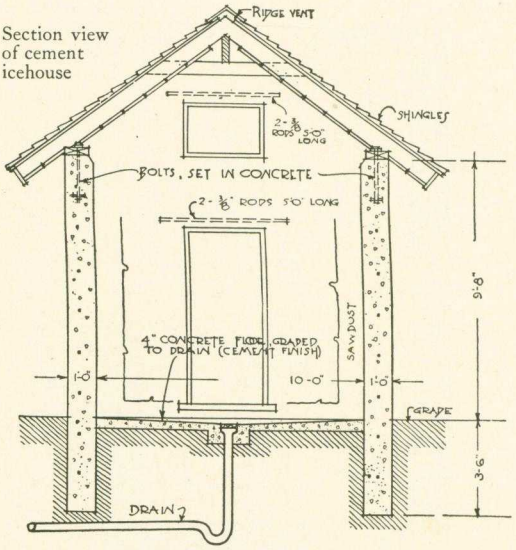
An icehouse should be located in a place convenient to the dairy barn, and on dry, well-drained ground. Building below the ground makes drainage difficult and removal of ice to the ground level equally difficult. It is generally more costly too, for an underground ice house requires the same material and expense in building as one above ground, in addition to the cost of greater excavation. The soil is a good conductor of heat. During a large part of the year, ice will melt less in a surface storage room exposed to actual contact with air than in underground storage.

One of the best forms in which to use cement for icehouse construction is hollow block. These should be of a type that will permit a wall being built with a practically continuous air space throughout for the insulation thus afforded. The floor should be in a measure insulated from contact with the soil, by being laid on a well-compacted 8- or 10-inch layer of clean pebbles or cinders free from ashes. If block is used in the construction, of course the type must be such as to permit suitable reinforcing to take care of the outward thrust resulting from ice pressure.



Cement icehouse

Section view of cement icehouse



Although the accompanying plans show a wood frame and shingle roof, a cement roof is by all means preferable. This also must be built so as to provide insulation which is accomplished by constructing, independent of each other, two sets of slabs suitably reinforced and separated from each other by a layer of clean, coarse cinders. There is true economy in the cement roof since it is permanent, and in connection with the remainder of the construction, accomplishes complete fireproofness.

ALPHA CEMENT — HOW TO USE IT

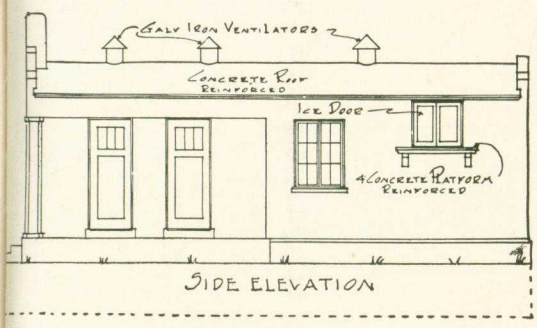
Cement Milkhouses

Many city health authorities having the power to regulate the conditions under which the city milk supply is produced, require that cement construction be used throughout dairy buildings on the farms furnishing milk, so as to make certain that sanitation can be maintained.

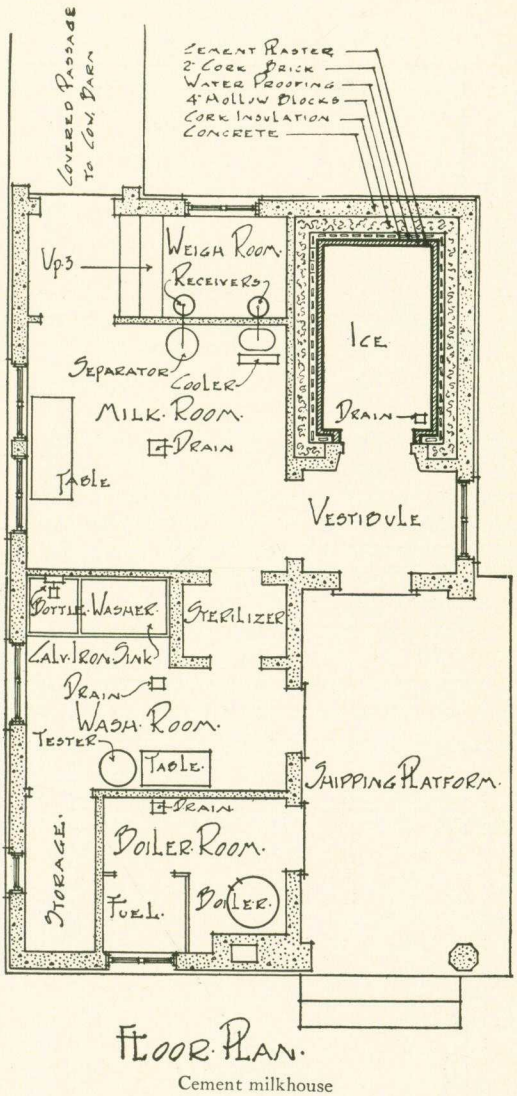
Accompanying designs show a very convenient layout for the dairy-farm milkhouse. Even the shipping platform is of cement construction, so that everything about the structure is permanent. Fireproofness also is secured, which is quite necessary since the boiler room is a part of the building. The method of securing insulation for the ice compartment is shown in detail. Otherwise its construction is not unlike that described elsewhere for a small icehouse.

In this design the shipping platform is specified as 4-inch reinforced concrete. It would perhaps be better if this were made 6 inches thick as it would then be easier to place reinforcing and make certain that it was everywhere surrounded by and perfectly bonded with the concrete.

Although a good interior wall finish can be obtained by mixing the concrete to correct consistency and carefully spading when placing in the forms, it is always desirable to have an exceptionally smooth wall in a milk room so that the surface can be kept thoroughly clean, and it would be well after removing forms to rub down the concrete to the desired smoothness by using a carborundum stone as described elsewhere under "Surface Finishes," and when the concrete has become thoroughly dry to give the wall several



Cement milkhouse



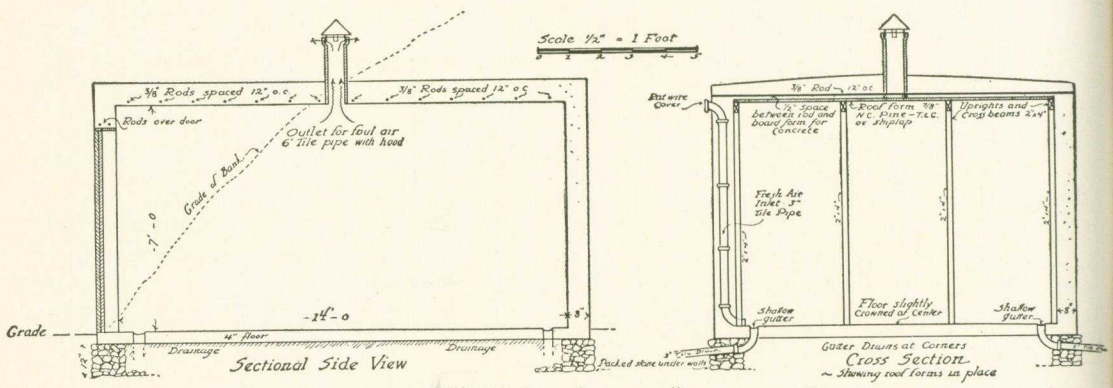
Cement milkhouse

coats of white enamel paint of a kind prepared especially for use on cement surfaces. This will seal any pores on th surface and will be an incentive to greate cleanliness, since any dirt that may lodg on the white surface can readily be seen.

Root or Vegetable Storage Cellars

Accompanying sketches show in plan an longitudinal and cross-section a cement fruit or vegetable cement storage cellar 10 by 14 feet. A structure of this kind should pref-

ALPHA CEMENT — HOW TO USE IT



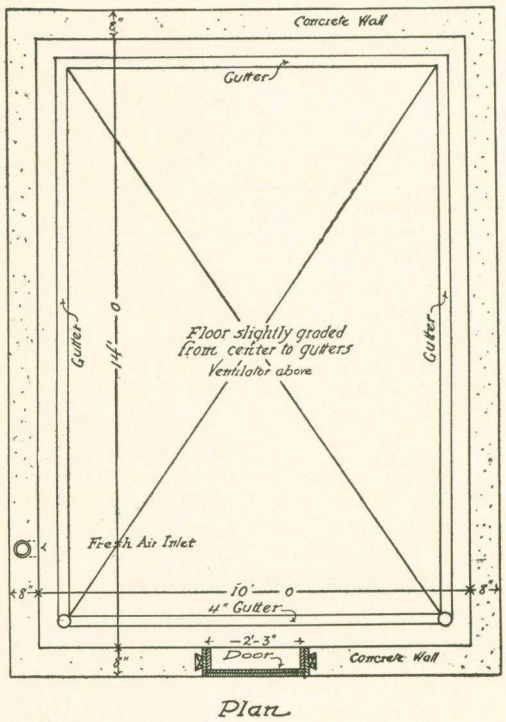
Sectional views of storage cellar

erably be located in a hillside or at one side of a knoll, and if so located the necessary excavating will provide sufficient earth to bank the structure and cover the roof, which although not essential, is desirable to assist in maintaining an even temperature inside the cellar.

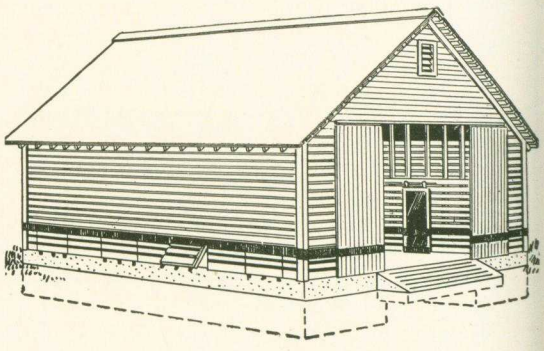
Although not shown on the plans, a structure of this kind should have reinforcing in walls, especially when set into the side of a hill or a knoll, to prevent earth pressure from cracking the walls. For a structure of this size 3/8-inch rods, spaced 18 inches center to center, will probably be sufficient. The sketches illustrate a system of ventilation, which is quite essential in such storage cellars to prevent dampness which would not be best for stored fruits and vegetables.

Ventilator pipes are of 6-inch cement tile. The vents should be covered with galvanized wire mesh to exclude rats and mice. It is a good idea to lay a raised plank floor over the cement one and to divide the cellar into bins with 2-inch plank partitions, nailing planks 1/4 inch apart on 2 by 4 studs so that there will be ventilation all around the stored contents.

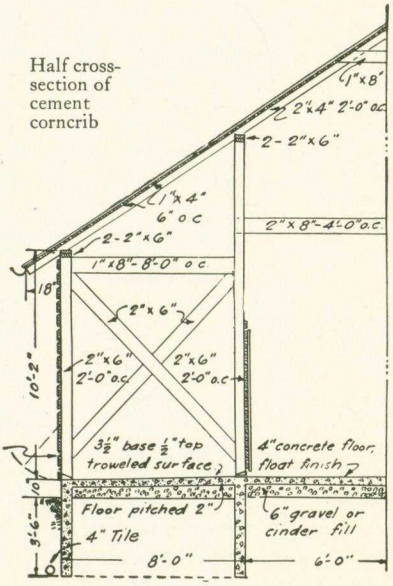
The roof of this structure also is reinforced with 3/8-inch rods, spaced 12 inches center to center in both directions. Another method of constructing this roof is to use metal lath stretched from dowel pins set into the concrete of the walls.

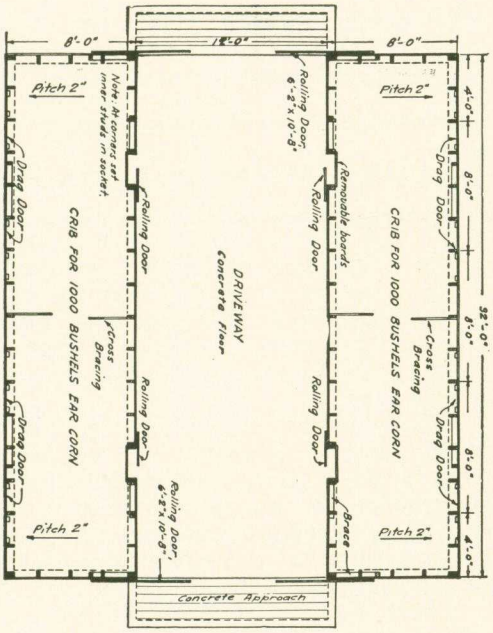


Cement storage cellar



Good type of corncrib





Plan of cement corncrib

Ratproof Corncribs

The accompanying designs show in plan, perspective and part section a ratproof corncrib designed by the United States Department of Agriculture, in which ratproofness is secured by cement foundation walls and floor and a fender strip that prevents the rats from climbing up side walls and thus securing entrance to the frame superstructure. The crib is a double one with a driveway between the two compartments, each of which has an estimated capacity of 1,000 bushels of ear corn. The driveway as well as the floors in the cribs proper are paved or floored with cement. Construction of such floors has already been described under the heading "Walks and Floors." In setting up forms for the cement floor in the cribs the form boards should be set so that the floor will have a slope of at least ¼ inch to the foot for drainage if rain should blow into the crib during a severe storm. This slope should, of course, be toward the outside.

It is now possible to build corncribs of cement throughout, several types of cement corncrib blocks having been perfected and commercial machines placed on the market to manufacture them. Such blocks have openings extending through them and slanting downward to prevent the entrance of rain. The block is so made that a wall built of it can be reinforced by laying rods in the mortar joint, the principle being similar to that used in cement block silo construction.

Cement Smoke-house with Outside Fire-box

Accompanying sketch shows a suggested plan for a reinforced cement smoke-house with fire-box placed outside of the building. The roof is shown as having a slight pitch, but if desired it can be made flat. In such a case it will not be necessary to embed timbers in the side walls to provide means for hanging up meat while smoking. Eye bolts can be linked around reinforcing rods in the roof and be embedded in the concrete of the roof.

The fire-box is so designed that in joining the smoke room there is a down draught, thus preventing the fire from burning too freely, and causing it to smoulder and smoke instead. Particular care should be used in selecting the aggregates of which the fire-box is constructed. The materials should be fire-resisting. See page 29. It would be well to use sheet iron lining for the fire-box, fitting this in place and using it as the interior form

while placing concrete. Generally speaking, such a structure should be at least thirty days old before put to use.

Barns, Stables, Silos, etc.

The advantages of a barn of cement construction are made apparent by what has already been said elsewhere about first cost, maintenance cost, proof against fire, vermin, weather and other deteriorating influences.

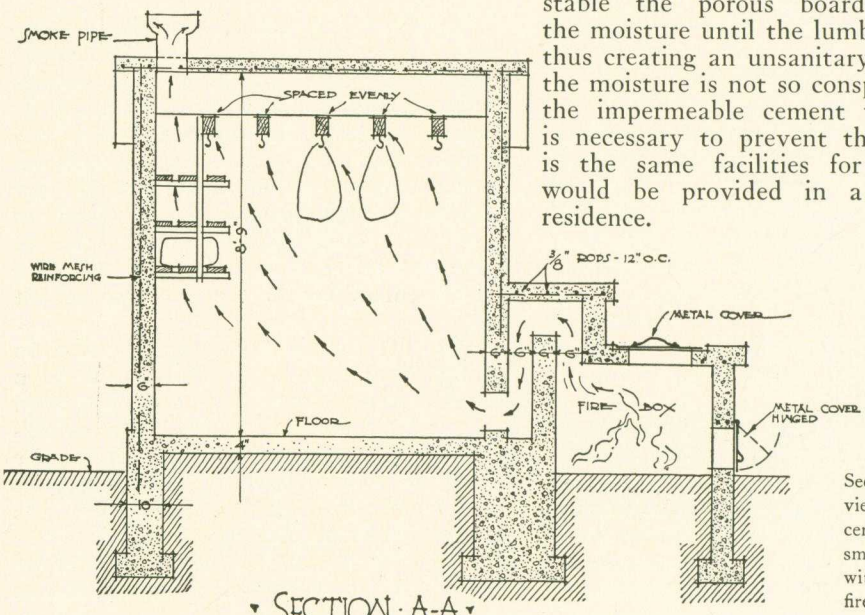
Barns may be built of block or monolithic cement construction. The foundation walls should be 12 inches thick, following in construction the suggestions made in the chapter on Foundations, on page 53. Walls above ground for two-story barns should be not less than 10 inches thick.

Floors should be built with care, as suggested elsewhere in this book. They should be 5 or 6 inches thick for one-course construction. Where animals walk or stand, the surface should be finished with a wood float to give an even but non-slipping surface. Over-troweling often causes checking. Barn floors should be laid in slabs not larger than 10 feet in any one dimension with joints extending clear through the floor, to prevent unequal settlement or cracks caused by expansion.

The accompanying sketches show a good design for a general purpose barn. The arrangement of horse stalls excludes odors from the dairy barn proper, from the feed room and other dairy apartments. The second story has a fireproof cement floor to protect the animals underneath should there be a fire in the hay storage.

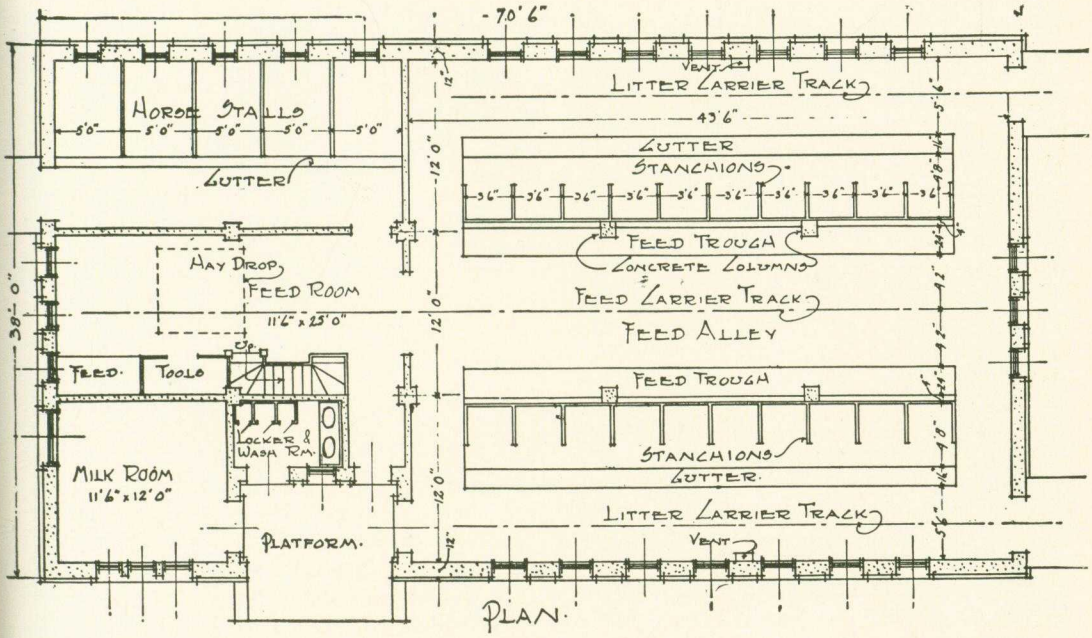
A cement floor is not more likely to give rheumatism to stock than is any other type of floor construction. To bed animals well protects them from rheumatism on any floor. If one insists, of course, wood block or cork brick may be laid over the cement, but such floors cannot be kept as clean as a cement floor.

Frost or moisture will accumulate on the walls of horse or cow barns, whether of wood, cement or anything else. These are signs of improper ventilation. Moisture accumulates in the stable air from the vapor exhaled by the animals. A mature cow throws off from the lungs about seven pounds of moist vapor per day. If the ventilation is such that this vapor is removed from the stable before it can be condensed on the cool cement surface, the question of dampness is solved. In cold weather the vapor turns into frost as soon as condensed. In a wood stable the porous board walls absorb the moisture until the lumber is saturated, thus creating an unsanitary condition, and the moisture is not so conspicuous as upon the impermeable cement wall. All that is necessary to prevent this condensation is the same facilities for ventilation as would be provided in a well designed residence.



Sectional view of cement smoke-house with outside fire-box

ALPHA CEMENT — HOW TO USE IT



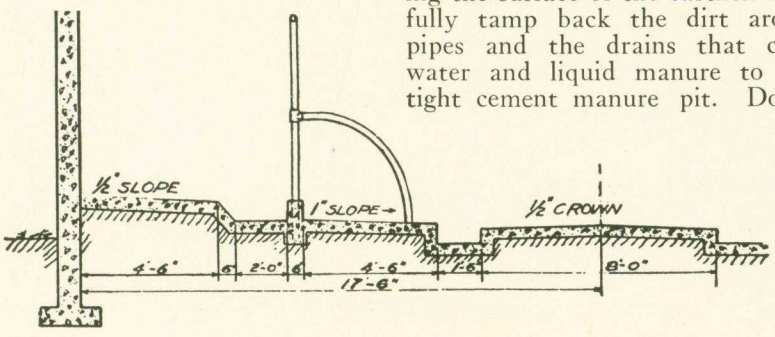
The accompanying plans provide good facilities for indoor lighting. The United States Department of Agriculture, Dairy Division, recommends 6 square feet of opening for each animal and gives 4 square feet as an absolute minimum. Windows should be placed near the ceiling and the height should be about twice the width.

Cement Stable or Barn Floors

If a barn floor is to accommodate two rows of cows standing heels toward each other, with a driveway between, lay out the stalls 3 feet 6 inches wide and 4 feet 6 inches in length from 6-inch manger wall to drop gutter. The manger is 2 feet 6 inches wide at the top and 2 feet at the bottom, with one face sloping up to the feed alley floor; the depth is 7 inches measured from the stanchion setting, and 8 inches from the alley floor. The feed alley is 4 feet 6 inches wide.

The drop gutter has a width of 18 inches. It is 8 inches deep gauged from the stall floor, which is 2 inches higher than the 8-foot driveway. (See cross-section illustration.) For establishing grade lines a carpenter's spirit level (or a water level) and a chalk line are very helpful.

To prevent possibility of the floor settling, remove all manure before grading the surface of the earthen floor. Carefully tamp back the dirt around water pipes and the drains that carry waste water and liquid manure to the watertight cement manure pit. Do all filling



Cross-section of cement dairy-stall, showing usual dimensions

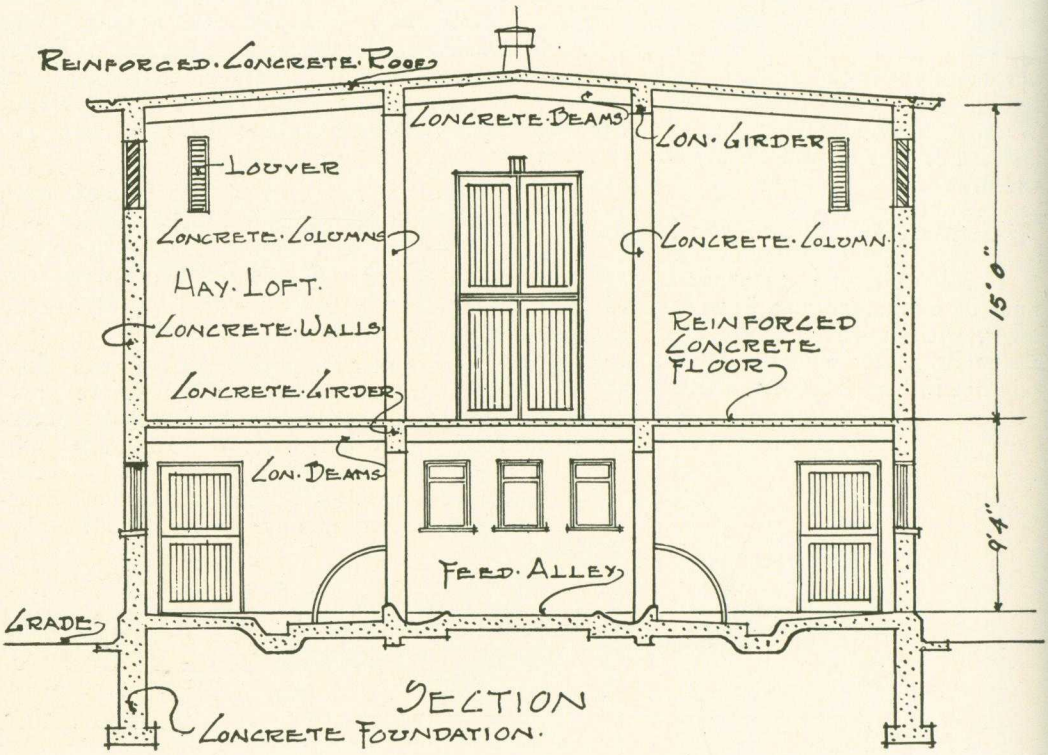
as long as possible before building the cement floor. As a foundation for the stall floors proper, place a 6-inch thickness of coarse broken stone or screened gravel to keep the floor from direct contact with the ground. As the stall floors are of first importance, it is well to make them first. During this operation the unpaved driveway and alleys can be used as working space. Then finish, in order named, the feed alleys, the driveways, the mangers and lastly the gutters.

Mixing and Laying the Concrete. For the plan given, first place a stout board on edge and to line and grade 5 feet 6 inches from the center line of the driveway, this to serve as a form for the stall floor at the gutter. Likewise set a similar board, 5 feet distant, to mold the 6-inch manger wall and stanchion setting. Bear in mind that the stall floor is to have a slope of 1-inch toward the gutter and that the stanchion setting rises 7 inches above the stall floor. Drainage for gutters and mangers will be provided by sloping their cement bottoms.

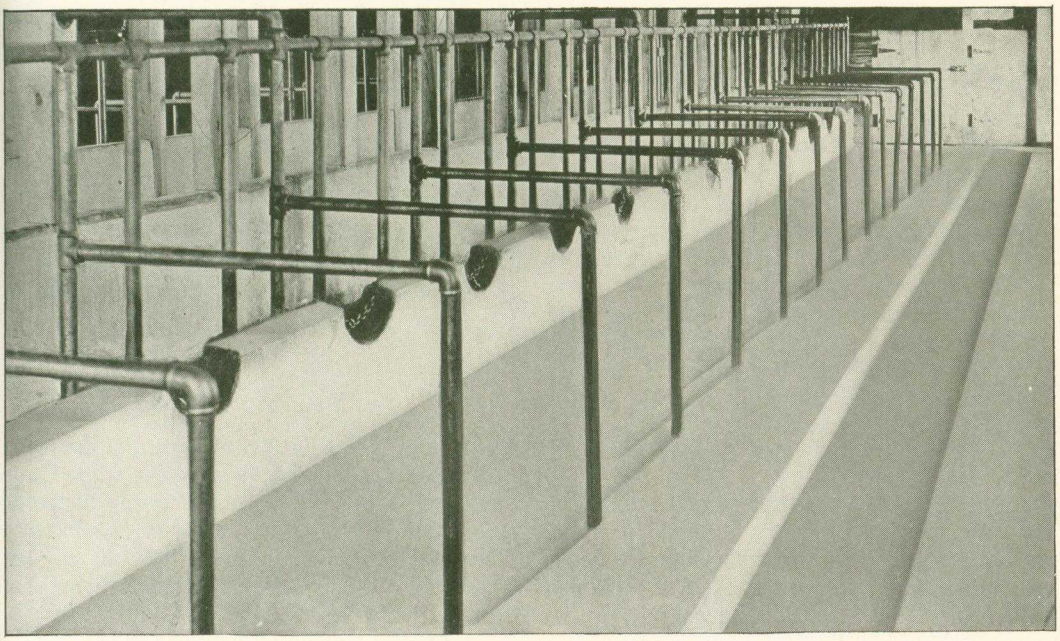
At one operation lay the full 5-inch thickness of the stall floor and finish three stalls the same as one section of sidewalk. When patented stall divisions are to be used, follow the manufacturer's directions; for home-made divisions, make mortises or holes by tamping the concrete around greased tapering wooden cores, which are withdrawn as soon as the concrete stiffens.

A wooden float is best for finishing the floor. A steel trowel yields a surface entirely too smooth, and such a finish should always be roughened by brushing with a stable broom.

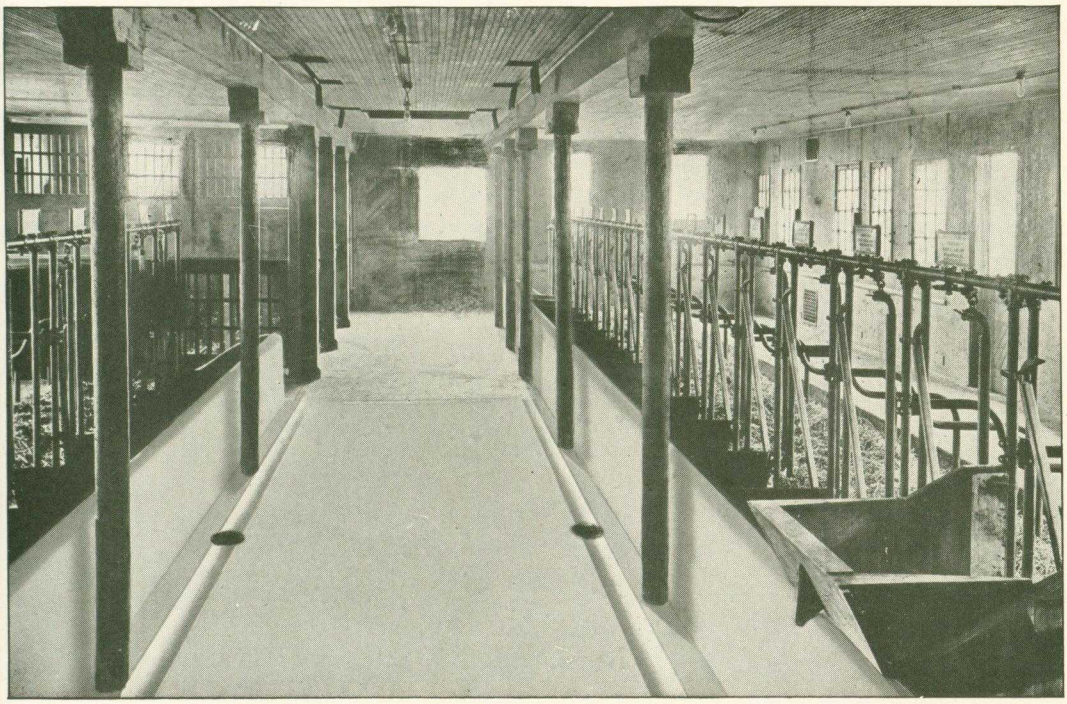
While the concrete of the three stalls is still soft, mold the stanchion setting (6 inches thick) upon it. If 2 by 12 pieces are used for the first forms, the projecting 7-inch height of the form already in place may be used together with two 1 by 6-inch boards toe-nailed together so as to provide another 7-inch height and a bearing plate



Combination cow-and-horse fireproof barn



View in a model dairy where cement replaced wooden floors

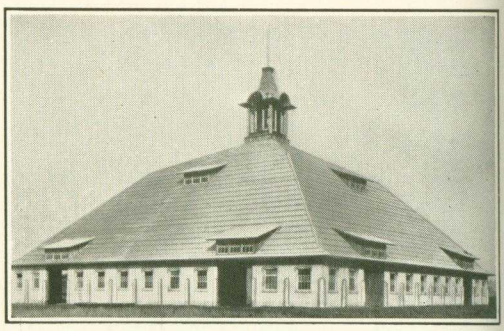


Model dairy barn, showing cement feeding alley between rows of stanchions

to the rest of the fresh concrete. These forms may be made dish-shaped for swinging stanchions. Fill the forms with mushy wet concrete, trowel the surface, round the corners, and set the stanchion holders. Repeat the operation until all stall floors are completed. The feed alleys and driveway are easily built; they are merely rough-finished sidewalks. Place the waste-water outlets in the mangers at intervals of 28 feet and give the bottom a slope of 1 inch toward each outlet for a distance of 14 feet on each side of it. The drop gutters may be drained in like manner or can be sloped slightly in one direction for their full length. For ease in cleaning, round angles and corners.

Caring for Cattle and Floor. Regardless of the kind of floor, bedding of straw or litter is an absolute necessity; it keeps the cow clean and absorbs the valuable liquid manure. If the help cannot be depended on to bed the cows properly, it is advisable to use a removable wooden grating or platform. Cork bricks, set in a 2-inch depression of the cement, are sometimes used.

With the proportions and thickness given above, 4 bags (1 barrel) of cement, 10 cubic feet of sand (say ⅜ cubic yard) and 20 cubic feet of crushed rock (about ¾ cubic yard) will lay 45 to 50 square feet of floor.



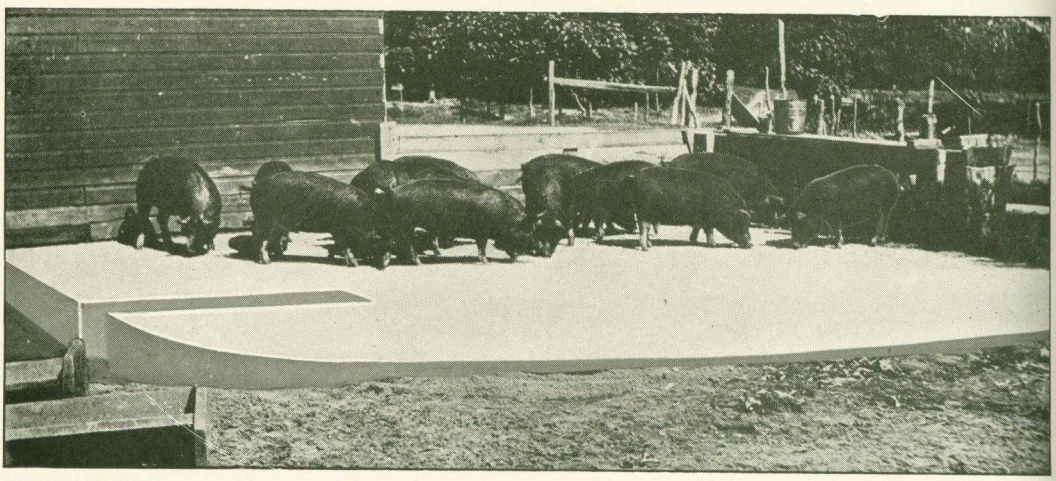
Sheep barn of Albert Peck, Geneva, Illinois. Largest of its kind in the State

Feeding Floors

When feed was thrown out on the old-fashioned feeding lot, part of it was eaten and part trampled into the mud—wasted. Wood feeding floors were no improvement. They harbored rats and often became so unsanitary as to menace the health of the herd.

Cement feeding floors which overcame all of these things, have been said by conservative men to be able to pay for themselves in a year where there is considerable feeding to be done.

Details of construction are similar to those described elsewhere under "Walks and Floors." The location should be one where drainage is good and if possible where the animals to be fed will be afforded protection from wind. The site



Cement feeding floors save grain, labor and fertility. They quickly pay for themselves

should be cleaned of all vegetation, and any soft spots dug out and refilled with gravel containing only a small amount of sand or with clean cinders free from ashes, and well compacted. Sometimes a sub-base is necessary as suggested on page 55. The floor should be sloped toward one side where there should be a gutter that is connected to a tile line leading to a manure pit so that all of the animal droppings on the floor can be preserved. In this way the cement floor is made a two-fold source of profit.

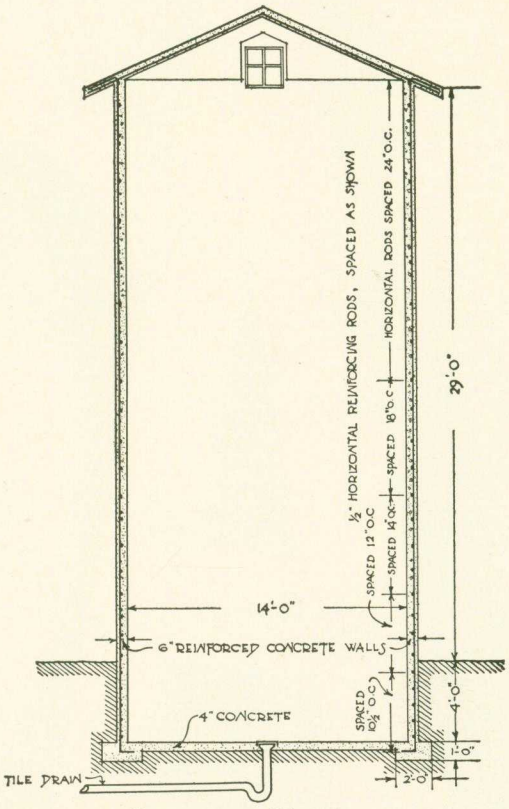
Feeding floors should be made preferably not less than 5 inches thick and of one-course construction, being laid in slabs no greater than 6 feet in one dimension (36 square feet in area). In finishing, one should use a wooden float instead of a steel trowel. The wood float finish largely does away with the possibility of hair cracking and leaves a gritty texture to the pavement surface that provides a good foothold. A cement feeding floor should be washed off occasionally with broom and water, and in case of stock disease and the necessity for thorough disinfection the surface may be sprayed with gasoline and the gasoline set afire, thus making absolutely certain that disease germs will be destroyed.

A feeding floor should always be built with a curb around it extending two or three inches above the floor level to prevent the animals from shoving feed off the floor when eating. This curb should also extend a foot or eighteen inches below the bottom of the floor to prevent rooting under it.

Cement Silos

Almost every farmer knows the advantages of the silo for preserving fodder, coarse hay, rape, vines, etc., so that winter feed may be succulent. The farmer who hasn't yet built a silo may be wondering which is the best type of silo for him.

Silo building is past the experimental stage. Of course, silage has spoiled in poorly built silos, and in silos of unsatisfactory materials. Silos themselves have dried out and been blown over; some were expensive to keep in suitable condition, and some were found after being built, to be unsuited to the owner's needs. These things will always happen as long as



SECTION THROUGH SILO

wrong methods of construction and wrong materials are used.

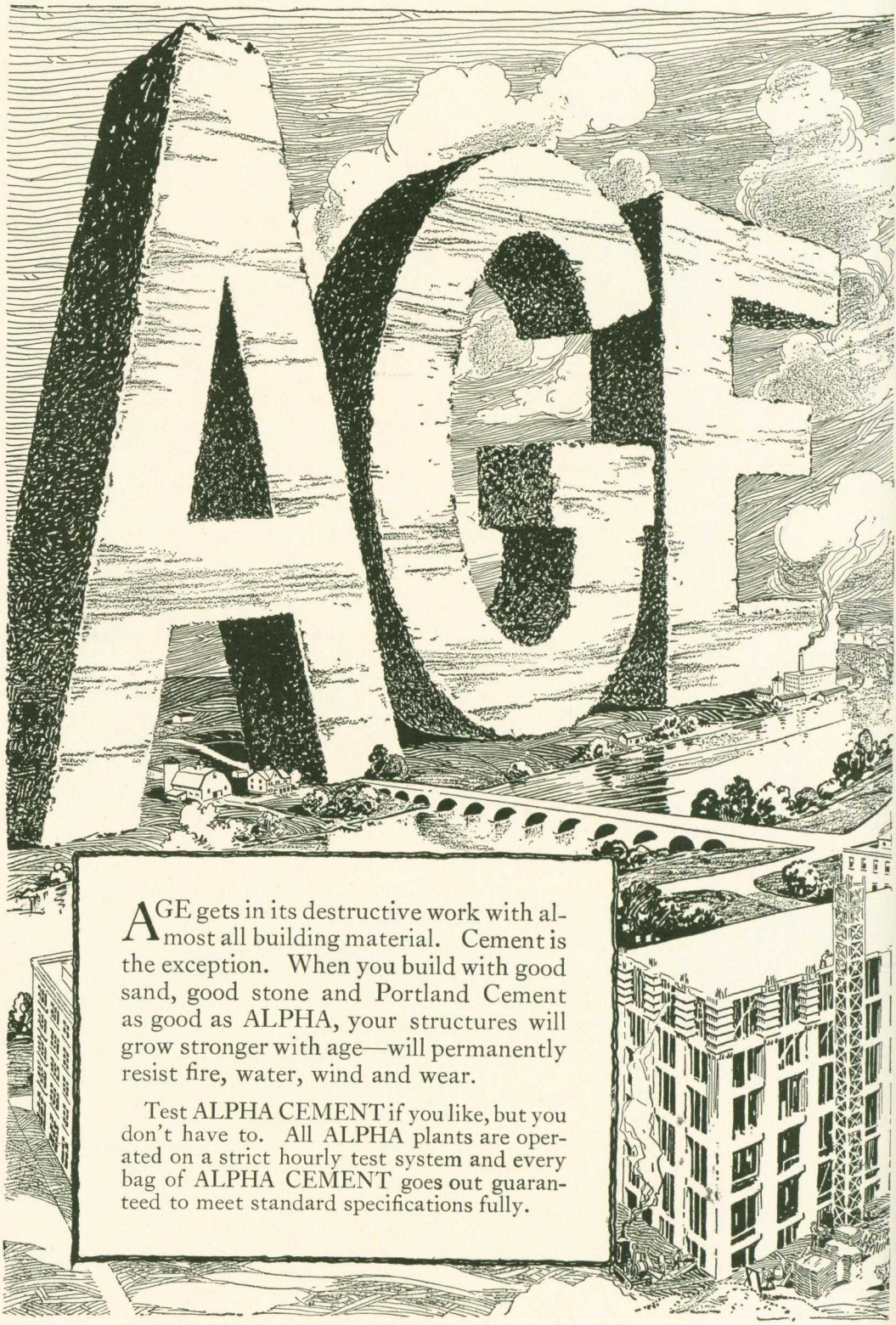
Cement in a silo or in any other building can be made and kept airtight, ratproof, waterproof and fireproof without the expense and with less depreciation than a structure of any other material so far known.

Cement silos can be made in various types—of cement staves, cement blocks or monolithic. All of these have desirable features, though the monolithic silo has peculiar advantages.

It is like one solid piece of stone, standing secure whether full or empty.

A cement silo is fireproof. It is not at the mercy of lightning or neighbors' fires. A cement silo is insurance against high feed prices for it retains fodder from one fresh-feed season to the next.

It is desirable, as a rule, to have a competent contractor with experience in cement work build the silo. It is not impossible, however, for a farmer himself



AGE gets in its destructive work with almost all building material. Cement is the exception. When you build with good sand, good stone and Portland Cement as good as ALPHA, your structures will grow stronger with age—will permanently resist fire, water, wind and wear.

Test ALPHA CEMENT if you like, but you don't have to. All ALPHA plants are operated on a strict hourly test system and every bag of ALPHA CEMENT goes out guaranteed to meet standard specifications fully.

to build a small or medium-sized silo of cement. It is merely necessary that the established principles of good cement construction be closely followed.

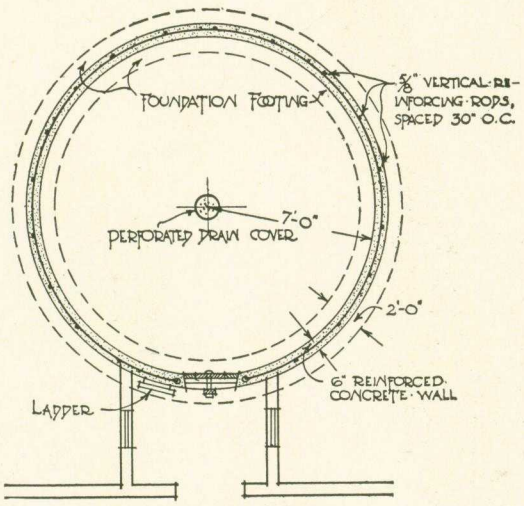
Excavating should be deep enough to bring the footings below possible frost penetration and rest them on a soil that is dense and firm. A drain is necessary in a silo. Provision should be made for placing it at time of excavating. It should be trapped to prevent the entrance of air which might tend to spoil ensilage.

Reinforcing is necessary in a monolithic silo, according to its dimensions. Mesh fabric (usually called triangle mesh) or steel rods are generally used. The manner of using is explained in the chapter entitled "Forms and Reinforcement."

In the accompanying sectional drawings of a 14 x 31-foot silo, the horizontal section shows that 5/8-inch rods are used as vertical reinforcing. The vertical section shows that 1/2-inch rods used for horizontal reinforcing, are spaced varying distances apart. For instance, the first five rods beginning from the bottom are spaced 10½ inches center to center; the next are placed 12 inches center to center; the next 14 inches center to center, and so on, the spacing increasing as the upper portion of the silo is reached. This closer spacing at the bottom is necessary to take care of the increased pressure on the walls due not only to the weight of the silo but to the large amount of liquid that may be and usually is present in the silage; in fact, the monolithic cement silo should be designed with a factor of safety that will provide for resisting the pressure of a quantity of liquid equal to half the capacity of the silo. The silage of some seasons is necessarily put into the structure while green and as it contains a large amount of water, this water pressure must be anticipated and provided for.

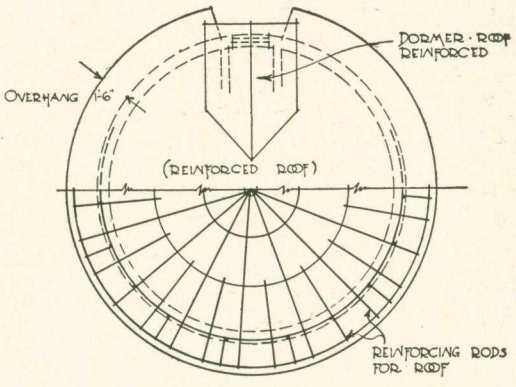
One very important detail of reinforcing is around and across doorway openings in the silo wall, through which feed is thrown. Such openings are usually enclosed by a chute of some kind which nowadays is made monolithic with the silo itself.

However the doorways are made and whether enclosed or not, the effect of continuous horizontal reinforcing must be preserved across the openings. For more



BARN.

PLAN OF SILO

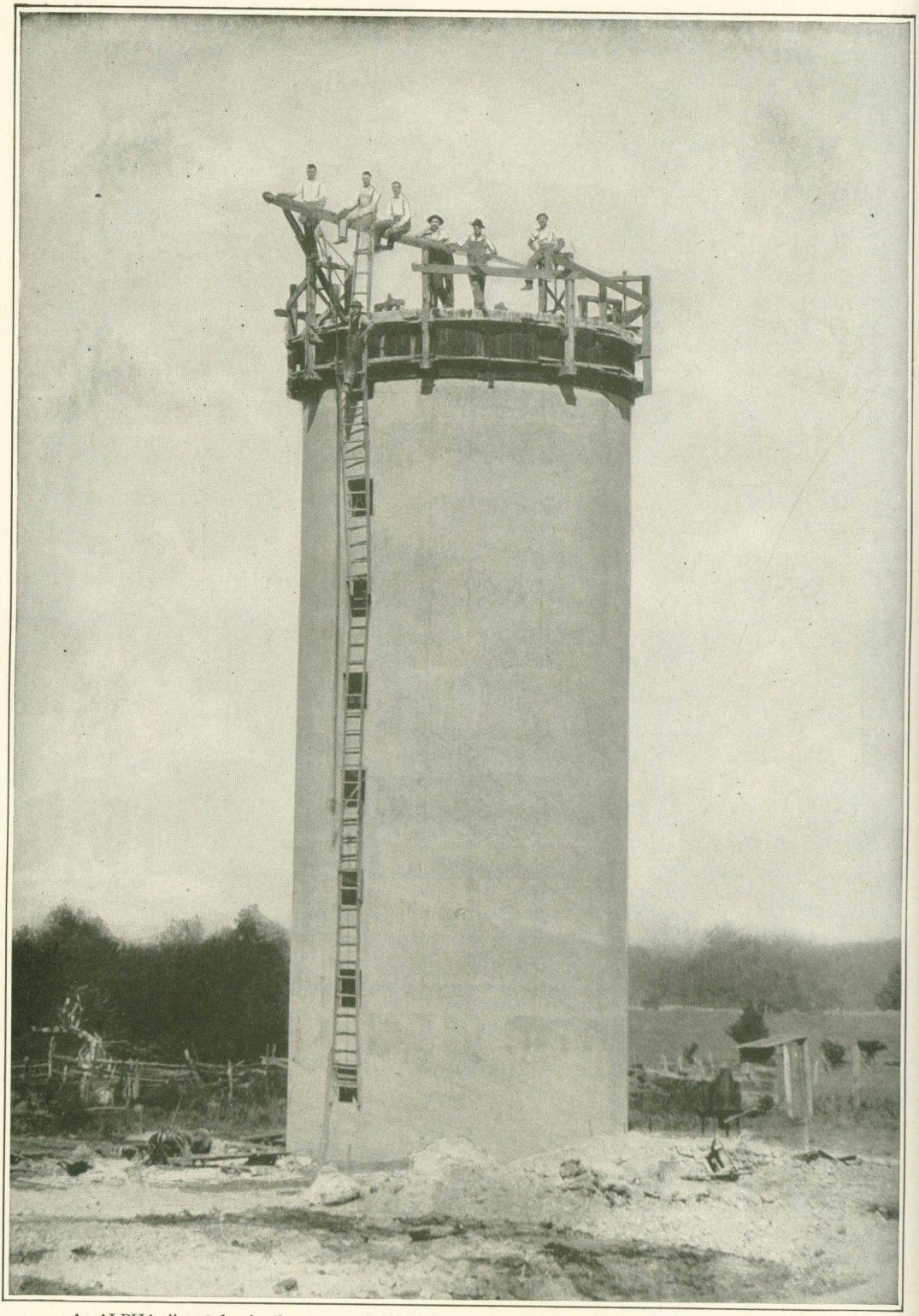


ONE HALF SHOWING REINFORCING FOR ROOF - OTHER HALF SHOWING DORMER ROOF LINES, ETC.

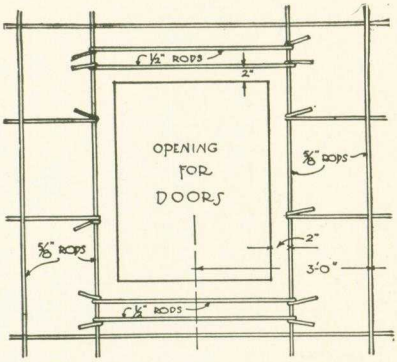
ROOF PLAN

strength, an additional rod is usually placed vertically at each side of the doorway. A suggestion for tying in the break caused by doorway openings is shown on page 77.

Roof for Silo. Above is a plan of a roof and the scheme of placing reinforcing. The quantity of reinforcing depends upon the area to be covered by the roof—the diameter of the structure.



An ALPHA silo, 18 feet in diameter, 50 feet high, on Woodlawn Farm, Avon, N. Y. Built October, 1911.
Mr. W. E. Dana, the owner writes:
"It is in perfect condition. The ensilage has kept perfectly to the edge. The silo has been extremely satisfactory and is the cause of a great deal of favorable comment by visitors at the farm."

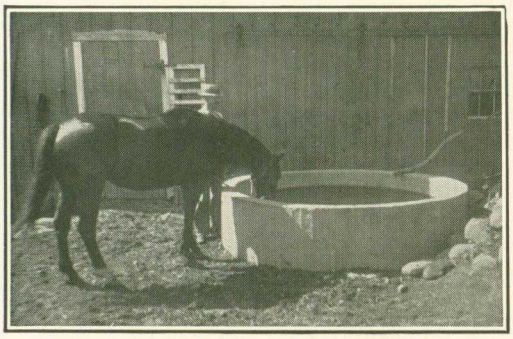


REINFORCING AROUND OPENINGS

Silo Wall Construction. The walls of monolithic cement silos are almost universally 6 inches thick, commercial silo forms providing for this thickness. Thinner walls have been used successfully, but it is difficult in a thinner section to keep the reinforcing exactly where it belongs in the wall, also to spade the concrete while placing so that a smooth exterior and interior wall surface is obtained. Reinforcing in silo walls is preferably placed exactly 1½ inches from the outer wall, but for convenience is usually placed at the center of walls.

Concrete must be thoroughly puddled or spaded in the forms, thus causing it to settle around reinforcement and make it possible when spading next to form faces to force back the coarse aggregate and produce a smooth surface finish to the structure.

Other Important Details. When work on walls must be discontinued, the concrete in the forms should be left rough so that a bond may easily be secured between it and the fresh concrete when work is resumed. Before resuming, however, the upper surface of the hardened concrete should be painted with a cement grout—a cement and water mixture of creamy consistency.



Cement watering trough made with silo form

The inside of the silo also painted with this cement grout will give the walls a smooth finish, permitting close packing down of silage.

Leaks in a silo are accountable only by missteps somewhere in the course of building. See the chapter headed "Making Concrete Watertight," page 30.

If a silo is constructed in warm weather, it should be cared for as suggested under the heading of "Protection of Fresh Construction." After forms have been removed, exposed aggregate or pebble pockets should be painted up with 1:2 sand-cement mortar.

Cement Block Silos. The cement block silo, as the name implies, is built of cement block similar to those used in other cement construction. These may be either hollow or solid. The blocks are molded in special machines in which they are given a shape corresponding to part of the circumference of a circle, so that when laid in courses each course forms a ring. The same details of manufacture govern the making of silo block as the other types of building block. Usually the limited use made of silo block by the farmer does not warrant the purchase of a machine for making them on the farm, so it is generally best to buy block at a nearby products plant. Also, as the work of laying them is a masonry job, it is best to employ a regular mason to lay up the block.

Excavation, floor and footing for a cement block silo are exactly the same as for any other type since all well-built silos, regardless of material used in the superstructure, must depend on concrete for the floor, footing and foundation. After the floor and footing are 24 hours or more old, the first course of block may be laid. The line along which to lay them can be marked on the top of the footing by a sweep just as the circumference for excavating the foundation trench would be

laid out. The first course of block should be very carefully laid to line, embedded in about ½ inch of 1:2 or 1:2½ cement mortar. Each following course of block is so laid that it breaks joints with the preceding one.

Block silos must be reinforced. Reinforcement is confined to horizontal hoops and these are usually embedded in masonry joints by providing a groove in the upper face of the blocks to receive the reinforcing rod. Intermittent doors with cement door frames are to be preferred for a cement block silo. In laying up block, mortar joints should be well filled to secure tight wall construction and as is sometimes done with monolithic silos, the interior may be given a coat of cement mortar paint when the structure is completed. The roof and chute also should be built of cement. The chute of a block silo is usually built of block specially molded for that purpose.

Cement Stave Silos. Both monolithic and cement block silos meet all requirements of the ideal silo. So does the newer type of cement silo known as the cement stave silo. This silo gets its name because of the units of which it is built. These are known as cement staves which are slabs of concrete usually about 2½ to 3 inches thick, 10 to 12 inches wide and from 28 to 30 inches long, depending upon the particular type of stave or unit. When laying up the wall, the staves are set on end and as the staves are made their edges are so formed that each one interlocks or meshes in some fashion with adjoining ones.

After having built footing, foundation and floors just as described for other types of silos, the first course of staves is set up by using full and half-length staves so that wall joints can be properly broken. This is carried on until the required height is reached, the last course consisting also of full and half-length staves in order to bring the top of the silo wall to uniform level.

The inside walls of cement stave silos are usually painted with cement mortar paint. Reinforcement in the form of hoops is placed on the outside, tightened by turnbuckles operated on the threaded end of these hoops.

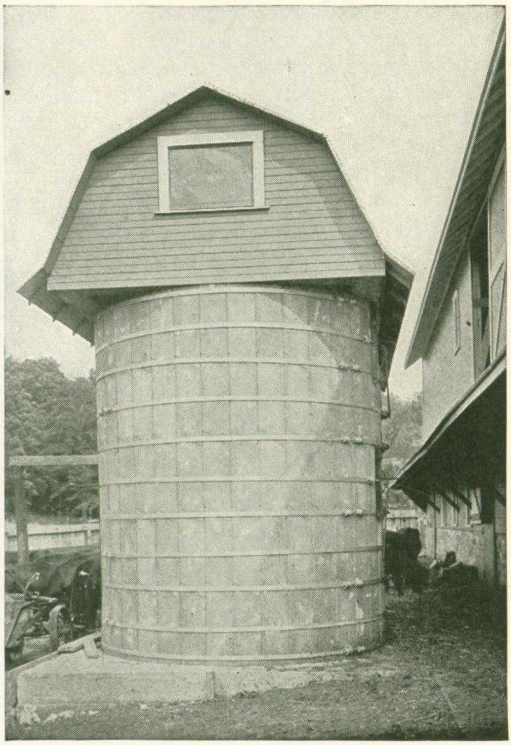
Cement stave silos can be built with continuous doorways from top to bottom without weakening the structure. Specially designed door frames of cement or steel are used to provide door openings ranging from 24 to 36 inches and convenient ladder steps are also arranged for. The silo is completed by a cement chute and metal roof.

One particular advantage of the cement stave silo which has caused it to rapidly increase in popularity in the past two or three years, is speed of erection. The cement stave silo can be put up in less time than any other type of masonry silo. Three days is sufficient to build one of the average size. Many products plants are now engaged in manufacturing cement silo staves and usually the plant making staves will contract also to erect the silo.

Cement Staves as a Unit for Building Structures Other Than Silos. The ease with which a building unit similar to the cement stave used in building silos can be set up, has resulted in modified forms of the silo stave which have been successfully used in building walls of a considerable

DIMENSIONS OF SILO ACCORDING TO SIZE OF HERD

Number of Cows in Herd	Feed for 180 Days				Feed for 240 Days			
	Estimated Tonnage of Silage Consumed	Diameter of Silo	Height of Silo	Corn Acreage Required at 15 Tons to Acre	Estimated Tonnage of Silage Consumed	Diameter of Silo	Height of Silo	Corn Acreage Required at 15 Tons to Acre
	Tons	Feet	Feet	Acres	Tons	Feet	Feet	Acres
10	36	10	25	2½	48	10	31	3½
12	43	10	28	3	57	10	35	4
15	54	11	29	4	72	11	36	5
20	72	12	32	5	96	12	39	6½
25	90	13	33	6	120	13	40	8
30	108	14	34	7½	144	15	37	10
35	126	15	34	8½	168	16	38	11
40	144	16	35	10	192	17	39	13
45	162	16	37	11	216	18	39	14½
50	180	17	37	12	240	19	39	16
60	216	18	39	14½	288	20	40	19
70	252	19	40	17	336	..	..	..



Grain bin built of cement staves

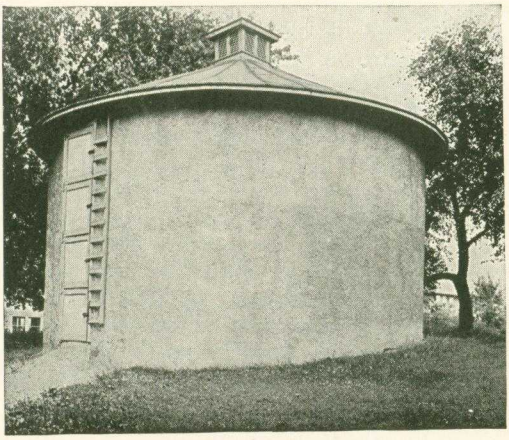
variety of farm buildings. There are several firms in the country that are now specializing on all-cement barns built of such cement staves. In general, the manner in which they are used consists of fitting them into grooved pilasters, the latter being cast either monolithic or laid up of pre-cast units. In this way the resulting wall has the appearance of pilaster and panel construction. Staves are also used for building a variety of cement tanks, grain bins, and corn cribs. In the latter types of structures special cement block are also used, the principal feature of staves and block used for corn cribs being openings in the unit, made rat- and mouse-proof by insertion of metal mesh when the units are cast. These openings also provide, in connection with an interior flue or chimney at the center of the corn crib, means for properly ventilating the contents.

Capacity of Silos. The size to build depends upon the number of animals to be fed daily and the quantity of silage in pounds required for each animal, as well as the number of days it may be necessary to feed them. Dimensions of a silo should be fixed in accordance with the size of the herd so that a day's feeding will represent the use of not less than 2 inches of silage. This will prevent the molding of a thin top layer. The ordinary dairy cow requires about 40 pounds of silage per day, and the foregoing table gives suggestions as to the dimensions of silo to build for herds of various sizes and to provide for different terms of feeding based on the 40-pound daily ration.

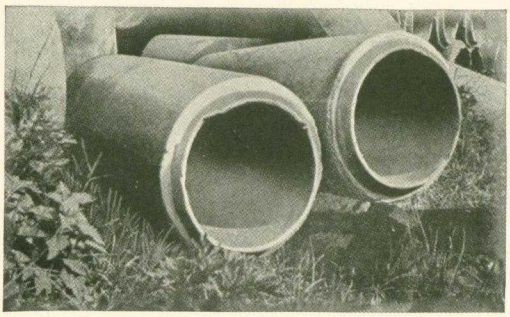
The first cost of a cement silo need not be higher than one of other material and of similar capacity. The maintenance cost, however, is nothing for a cement silo. It is proof against rats, mice, and spoilage; it requires no paint or repairs.

If no contractor is obtainable and the silo must be home-made, wood forms even though hard to build may be used. It would be better though if a group of farmers bought a commercial silo form and after each farmer had his silo built, rented out the form to others. Such forms can also be used to build round watering troughs, round milk houses, round smoke houses and ice houses.

Cement improvements advertise the fact that progressive people live thereabouts



Ice house built with silo forms



Cement pipe in fine condition after a generation of use

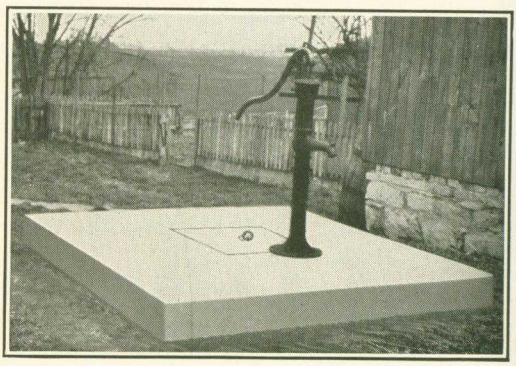
Other Cement Constructions

There are several methods of building a cement well platform. The choice is dependent on the manner in which the pump barrel and stock are joined together. In the illustration is shown a platform 5 inches thick and 5 feet square, which contains a manhole fitted with a cement lid. The pump stock passes through the platform by means of a circular hole at the side and a part of the manhole opening. By this means the pump stock and barrel can be joined together and slipped into position by a person working through the manhole. Afterwards the cement manhole lid is set in place. Moreover, this lid is heavy enough that it cannot be removed by a child.

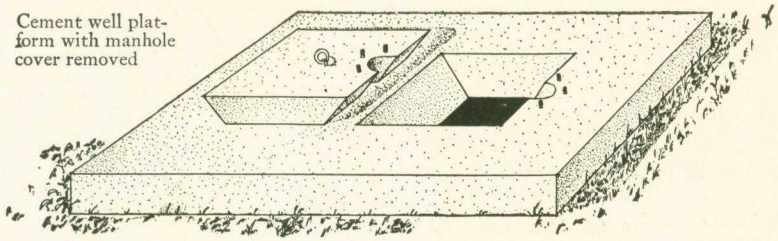
In preparing the well for a cement platform, see that 4 or 5 feet of the curbing near the top of the well is of solid concrete, or of blocks or bricks laid up with cement mortar mixed in the proportion of 1 part cement to 1½ parts sand. Carry the curbing 6 or 8 inches above natural ground level and grade the turf to this height so that surface water will flow away from the well. Prepare to mold the cover on a wooden platform of 2-inch boards laid over the well or placed on a level spot of ground. For most wells, a platform 5 feet square by 4 inches thick is sufficiently strong. To provide for a manhole opening, build a bottomless box, of 1 by 6-inch boards, 5 inches deep, 2 feet square at the top and 18 inches square at the bottom—outside measurements. Another plan is to have a tinsmith make a round bottomless tin form 5 inches deep, 2 feet in diameter at the top and 18 inches at the bottom, after the pattern of a large bottomless dish-pan. To either manhole form attach a wooden block of the size and shape of the pump barrel or stock. Grease the manhole frame and set it on the wooden platform where the opening in the well cover is desired.

Have the concrete just wet enough to flush a little cement mortar when tamped into place. Over the entire wooden platform, except within the manhole frame, spread 1 inch of concrete. For reinforcing, immediately place on this concrete 5-foot lengths of ⅜-inch iron rods running in both directions (criss-cross) and spaced 9 inches apart. Bend the ends to a hook-shape. Strengthen the platform around the manhole opening by placing an additional rod on each side. Bring the cover to its full thickness at once by tamping in the remaining 4 inches of concrete.

For fixing the base of an iron pump securely to the finished well platform, place in the soft concrete around the pump opening ordinary bolts (washered and heads down) to the depth of 4 inches. To locate these bolts correctly, set them by means of a wooden block or template in which holes have been bored and spaced exactly like those in the pump base. Lag bolts or similar devices may also be used for this purpose. Finish the surface of the platform with a wooden float, just as would be done in the case of sidewalks. If the greased tin form is used, the manhole cover may be cast at the same time as the rest of the floor. Reinforce the lid with short lengths of iron rods laid criss-cross.



Sanitary well platform of cement



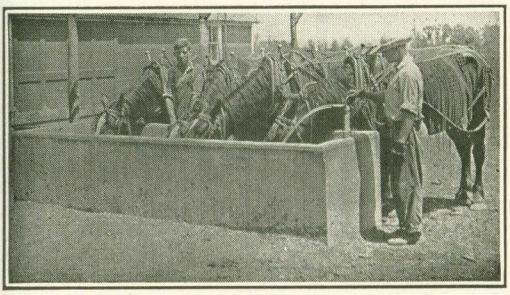
Cement well platform with manhole cover removed

As a lifting ring use half of an old bridle bit, or a hitching-post ring, the end of which is provided with a knob of twisted wire or with a nut and large washer. If the wooden manhole form is used, carefully remove it after four hours. One day later build the manhole lid the same as for the tin form with this exception—place greased paper or cardboard around the edges of the opening to prevent the new concrete from sticking to that of the platform. To make the manhole lid lighter in weight, before placing the concrete, spread 1½ inches of wet sand over the wooden platform inside the manhole opening and then tamp in the concrete. Take care to place the reinforcing within 1 inch of the bottom of the manhole lid.

After the well platform is two weeks old, carefully remove the wooden boards on which it was built and set or lower it into place.

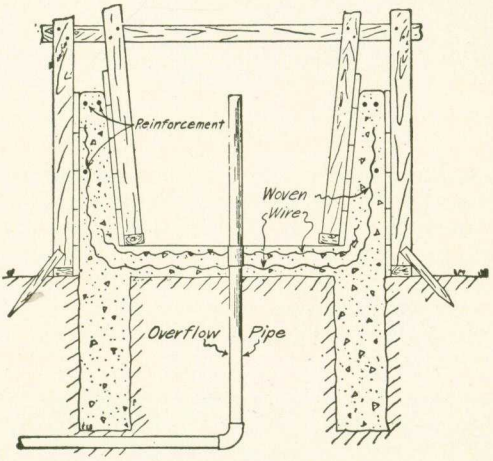
Feeding and Watering Troughs or Tanks

Cement tanks or troughs are more easily kept in sanitary condition than those of any other material and they have a very decided advantage from the standpoint of permanence.



Good type of cement watering trough

It is of course essential that tanks or troughs which are to hold liquids shall be watertight; see page 30. It is also necessary where possible to arrange for it, that the work be carried on continuously from start to finish so as to prevent construction seams in the work through which leakage could take place. See the chapter on "Forms and Reinforcement." If concrete is thoroughly spaded in the forms



Cross-section of cement watering trough showing forms and tank with reinforcement

while placing, particularly next to form faces, the resulting surface will be smooth, dense and watertight and will need but little pointing up after forms have been removed. If a smoother finish is desired the whole structure can be painted with a cement grout paint.

A batter or slope should be given to the inside wall face of troughs and tanks so that in case the contents should freeze the ice will rise, thus relieving the tank from the pressure of expansion; otherwise they are likely to crack.

Small tanks and troughs can readily be cast upside down as shown on page 23,

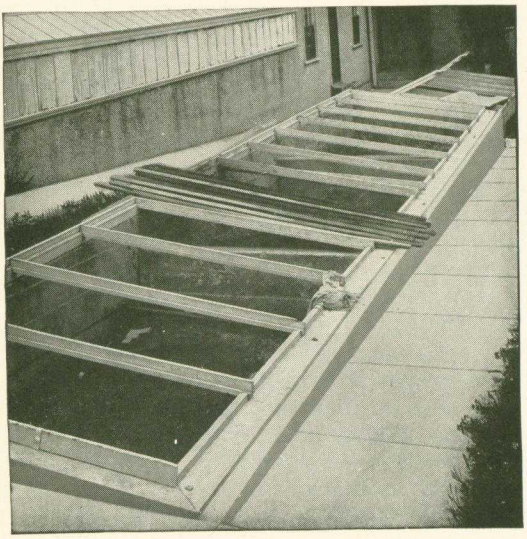
and when the concrete has hardened sufficiently to permit removing the forms they can be protected as suggested elsewhere for fresh concrete, and after ten days or two weeks may be carefully moved to the place where they are intended to be put to use.

In watering troughs or tanks such as are used in the barnyard or pasture lot, it is sometimes necessary to arrange for water inlet and outlet pipes passing through the floor or bottom of the tank. Provisions can be made for this when setting up the forms, as shown by the illustration on the preceding page.

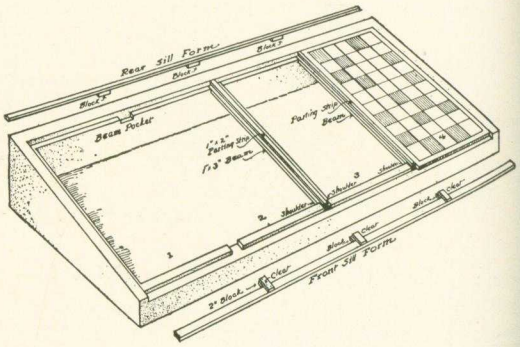
As in many other classes of cement work, the best materials and workmanship will count for little or nothing unless the concrete is properly protected after being placed to prevent too rapid drying out and this is very important in connection with troughs or tanks, which if allowed to dry out rapidly would be porous.

Hotbeds

Most of the wood used in hotbed construction is in contact with the soil and rarely lasts more than two seasons, while if concrete were used such construction would be permanent and the slightly increased first cost would soon be compensated for by doing away with repairs and rebuilding.



Well located cement hotbed



Perspective view of hotbed showing the last sash in place

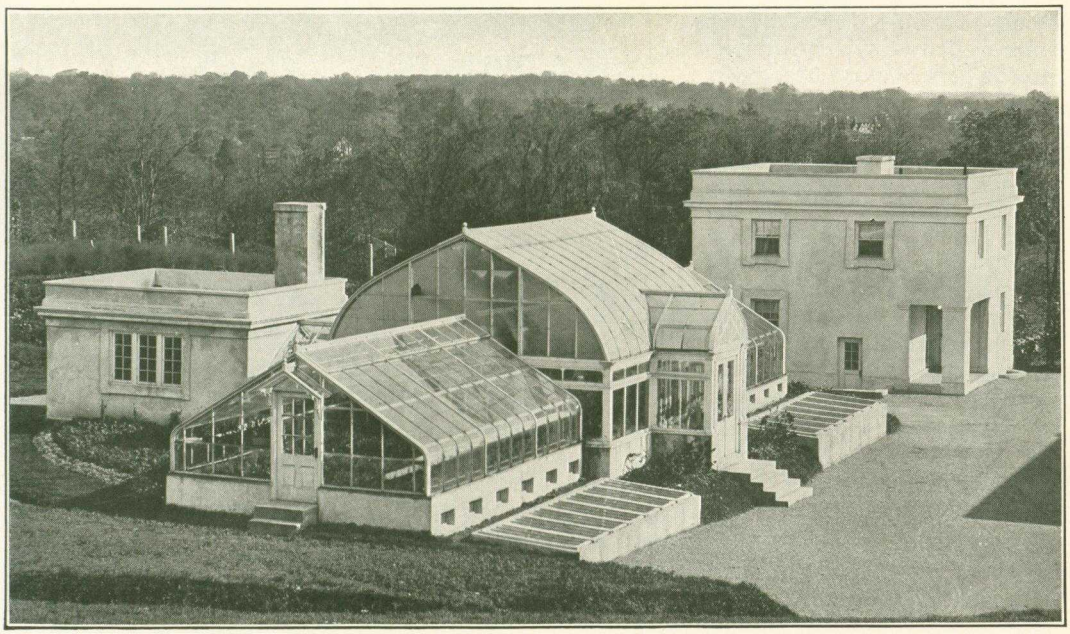
Usually cement hotbeds require only the simplest of form construction, and where the ground is self-sustaining only an inside form will be required for the cement work below ground level. At ground level, both inside and outside forms must be provided for the walls above ground.

For hotbed construction a 1:2½:4 concrete will be suitable. Walls should be from 6 to 8 inches thick with two ⅜-inch round rods bent to a right angle at each corner, these rods being 4 feet long and extending 2 feet into end and side walls. When finishing the back wall (which is the higher one) to provide for slope of sash, it is very easy to embed fastenings in the concrete for attaching sash hinges. A very convenient adjunct of the cement hotbed is a two- or three-foot cement walk on the low side, so as to make it easy to get around the bed during periods when the ground is wet. This feature considerably increases the ease and comfort of working in and around the bed. No stretch of cement hotbed wall should be longer than 25 feet unless reinforced or unless the next section is completely divided from it by a contraction joint, as the expansion and contraction due to temperature changes in a stretch of hotbed wall longer than 25 feet is quite likely to result ultimately in cracks in the wall.

Greenhouse with Cement Walls, Floors and Benches

In the hot, moist air necessary for cultivating or forcing plants under glass, wood construction soon goes to pieces from

ALPHA CEMENT — HOW TO USE IT



Attractive grouping of gardeners' house, workroom, greenhouses and hotbeds, at Greenwich, Conn. (Lord & Burnham Co., builders, Carpenter & Blair, architects)

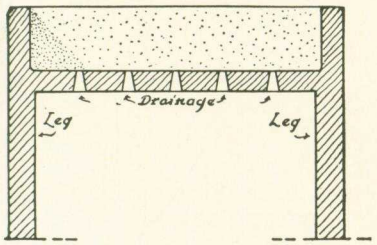
rot. This suggests cement for all portions of a greenhouse which need not be of steel frame and glass.

Accompanying sketches show in section a greenhouse with cement walls, floors and benches, and detail of the benches or beds.

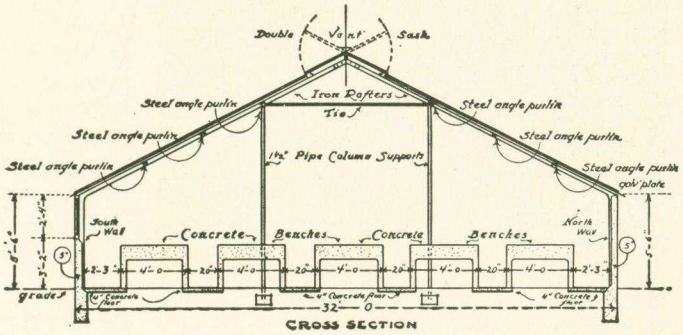
Walls for this structure may be from 8 to 10 inches thick, depending upon the weight of superstructure. Ten inches would be sufficient in extreme cases, 8 inches enough for all ordinary cases. Walls should start on a footing far enough below ground level to prevent disturbance from frost. Floors may be 4 inches—which is thick enough if no trucking is to be done over them, but in the latter case an added inch would be preferable. Slabs should not be larger than 6 x 6 feet.

Although the benches shown in this design represent monolithic cement constructions, some prefer the sectional benches, which can be assembled or dismantled as desired. Sectional benches can be molded in spare time and erected when needed. Ordinary laborers with competent supervision, can make them. Earth can be rapidly shoveled from them. They do not deteriorate in or out of use, and afford no lodging for vermin.

The cost of a cement bench 100 feet long and 5 feet wide, set up in place and

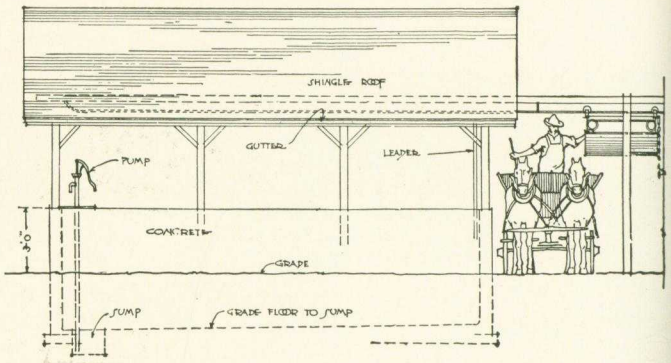


Cross Section of Bench
Showing Drainage Device
Wilson-Hoyt Method



CROSS SECTION

ready for use, should not under ordinary conditions exceed $50. Unless firmly set, the monolithic bench may, as a result of settlement, crack, especially if not properly reinforced, while if the sectional bench is subjected to settlement none of the parts of which it is composed will be injured. It is also unnecessary to provide special drainage facilities in the sectional bench, while in the monolithic type, some form of perforations must be provided in the base or floor of the bench to permit drainage and proper aeration of the soil.



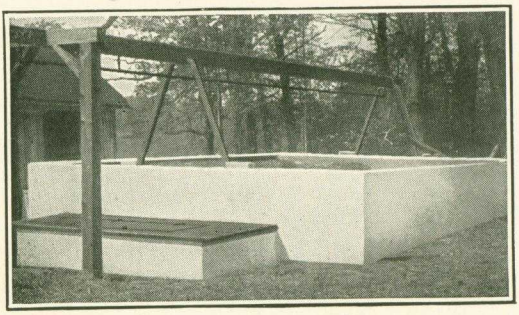
Side elevation of good form of covered pit

In a cement greenhouse, there is no rotting or fungus growth, which may bring on plant diseases. Cement floors and benches are easily cleaned by washing.

Manure Pits

Cement construction is ideal for the proper handling of manure until it is convenient to haul it out to the fields. Every particle of the liquid content which contains the greater proportion of the fertilizing elements, can be preserved and restored to the soil.

Usually a manure pit is constructed in some manner after the accompanying sketches, that is, either with or without a roof, and with a sump or cistern into which the liquid contents will drain and from which they can be pumped for sprinkling on the land when convenient.



Manure pit on farm of Haverford College (Haverford, Penna.) constructed with ALPHA CEMENT. In front is tank from which liquid manure is pumped

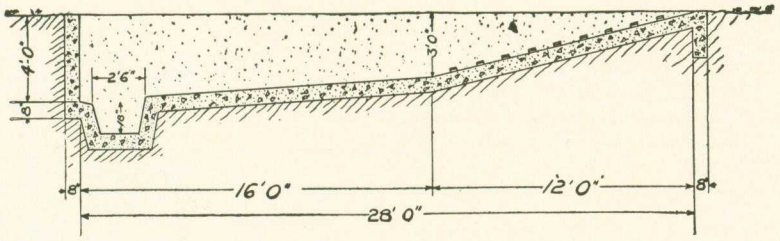
In the chapter headed "Forms and Reinforcements" may be seen additional details of its construction. It is quite desirable to roof the pit and screen it with fly screen fabric, to prevent the manure pile from becoming headquarters for fly breeding. This is especially true on the dairy farm, where milk must be cared for in a sanitary manner, which means keeping flies down to a minimum.

Manure pits should be conveniently located with reference to the barn so that if desired litter can be carried directly from the stable to the pit by a litter carrier, as shown in two of the accompanying views. The inside wall face of the pit should be sloped and all corners slightly rounded so that the manure can be properly packed in the pit to thus regulate or control decomposition. Some pits are built without a wall at one end and the floor sloped upward to ground level so that a wagon can be backed in for loading. In most cases a relatively shallow pit is best; that is, one where the manure cannot be piled to a greater depth than 3 feet. Where the pit is built almost entirely above ground, two $\frac{3}{8}$-inch horizontal rods spaced 12 inches apart, commencing 4 inches from the top of side walls and extending all around the structure, may be embedded in the concrete for the purpose of preventing cracks due to temperature changes, particularly at corners.

Septic Tank

Wherever a residence can be connected to a city or town sewer system this is, of course, the ideal way of disposing of house

ALPHA CEMENT — HOW TO USE IT



Sectional drawing of shallow cement manure pit

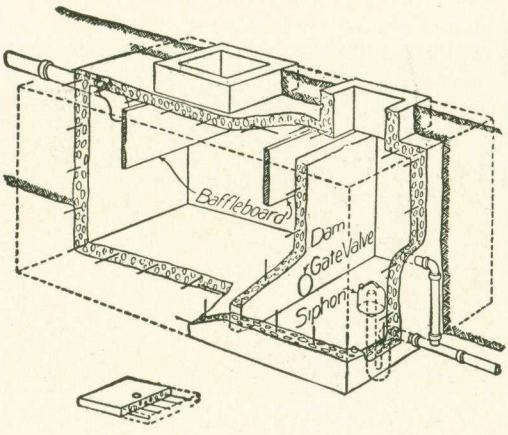
wastes. But in small communities and on the farm where houses cannot be so connected, it becomes necessary to devise some safe and inoffensive way of taking care of house wastes. Cesspools are unsafe and unsanitary even when handling waste from house plumbing, as their very environment is often favorable to a rapid multiplication of disease germs. Furthermore, if the cesspool is not walled in so that the structure is leak-proof, the wastes are quite likely, sooner or later, to contaminate a nearby well which is usually the source of domestic water supply. And even if walled in so that contents cannot seep from it, cesspools must be pumped out periodically—an unpleasant and very offensive task.

Modern sanitary science has developed for the isolated home the septic tank, which preferably should be built of cement. Many persons have built structures which they thought were septic tanks but in reality were nothing but cesspools through which the sewage passed continuously and with but little alteration. Every septic tank should have at least two compartments, one of these being a sort of settling or digesting chamber in which the sewage is held for a certain length of time and where it undergoes a preliminary decomposition owing to the action of certain bacteria which takes place in this compartment if it is kept practically air and light tight.

An accompanying design shows an approved form of septic tank. Construction details of this work are not unlike those of ordinary tank construction, the difference being that the structure has a roof or cover slab. This can be built several days after the side walls have been finished, and the vertical reinforcing rods can be allowed to project far enough above the concrete of the side walls so that projecting ends may be bent over and form a part of the reinforcing for the cover slab.

As a rule the first compartment should not be less than 6 feet deep, and its size should be planned so that the capacity will equal 50 gallons per day for each member of the household to be accommodated. Baffle boards shown in this first compartment are for the purpose of preventing any disturbance of the scum or sludge that forms in this compartment after bacterial action is started. This scum must not be allowed to pass from the first to the second compartment, for the latter contains an automatic device known as a siphon which periodically empties this compartment and allows the contents to be distributed to tile lines or open ditches, adopted for final disposal.

A cement septic tank must, of course, be watertight; see page 30. As in other tank construction, concrete must be mixed to quaky consistency and be well spaded in the forms. After side and partition walls have been built, studs are set up and a floor built for supporting concrete



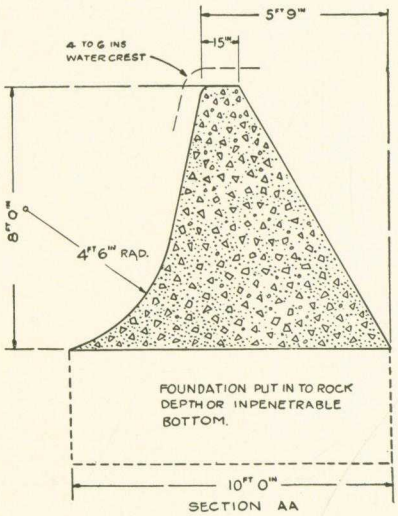
Sectional view of cement septic tank

for the roof or cover slab. A bottomless frame is set on this platform at the point desired for manhole openings, these manholes being for the purpose of providing access to the compartments when necessary to clean out the tank, which usually is not required oftener than once a year. Side walls and cover slab should be properly reinforced with steel rods spaced in accordance with the requirements, depending upon the size of the tank.

Before deciding to install a septic tank or before building one, consult either the state or county board of health, so that competent advice may be obtained as to the type of tank and final disposal system suited to local conditions. A great deal of the success of the septic tank depends upon a wise choice of the method of final disposal, and this choice is often influenced by the amount of land available for the purpose. Where possible to do so, two or even three disposal fields are better than one, allowing one of the disposal beds to rest for several days longer, if necessary, while the other is caring for the discharges of the tank.

Cement Dams

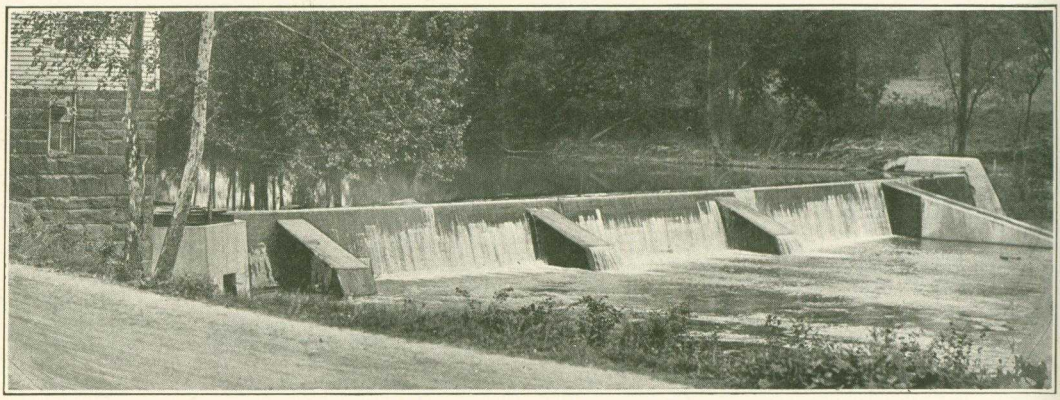
A small dam on many a farm would help to form a pond from which the home supply of ice might be harvested. Then too, such ponds may be used for fishing, swimming, rowing, etc. In many other places there are streams carrying a reasonable volume of water which if permanently dammed, could be made to do profitable work if means were available to harness this power. Of course the design of such



Section of small cement dam

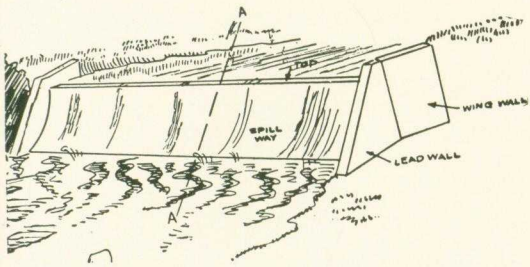
structures depends much upon conditions at the actual site of the work. This must be understood as referring to the small dam, such as is shown in accompanying perspective and sectional drawing.

Dams must be heavy enough and sufficiently anchored to oppose a force of water standing against them, to prevent being moved from their foundations or from being toppled over. A dam must be so designed that the flow of water over the crest will, when falling down the face strike in such a way as to be deflected and at once directed downstream. This is accomplished by shaping the face to a curve that deflects the water into the stream bed, or by building an apron on



One good style of construction

ALPHA CEMENT — HOW TO USE IT



Perspective view of another type of cement dam

the lower part of the dam to prevent the falling water from pounding at the base and weakening or undermining the foundation.

Sometimes dams are destroyed by the freezing of impounded water and unless exceptionally massive construction is used, reinforcing is necessary to prevent injury from the stresses caused by the expansion when ice forms in the pond.

In the best types of construction, the upper face of the dam is battered, that is, sloped so that the ice will rise when forming and thus relieve the dam from the pressure of expansion.

For ordinary small dams such as might represent construction on the farm, the concrete mixture used should be a 1:2:4. In most cases the home worker will find it inadvisable to attempt the planning and construction of a dam. Some competent engineer should determine foundation conditions and requirements and suggest or design ways and means of anchoring the dam. In some cases dams have been built in a manner similar to walls of buildings, these walls being reinforced and braced against overturning at intervals by reinforced buttresses; in fact, many large structures have been built in such independent units.

Rollers of Cement

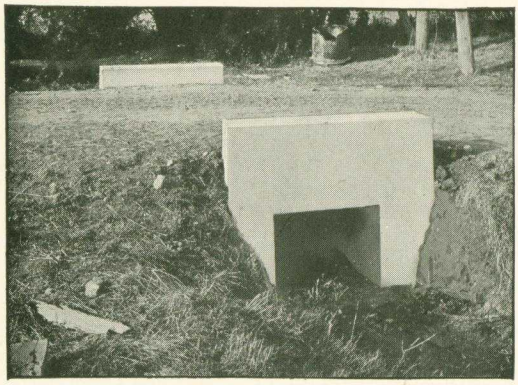
Rollers were originally made from logs of wood. These were abandoned for the more expensive iron rollers. Today these are being largely replaced by cement rollers. An iron roller with a cylinder from 2 to 3 feet in length will cost from $15 to $20, whereas one of the same size constructed with cement should cost much less.

Obtain a length of sewer pipe, of the size of roller desired. A tile from 12 to 24 inches in diameter will usually suit the purpose. Set this tile on end, small end down, on a wooden platform. Through a hole bored in the platform insert a 1-inch round iron bar, long enough to project beyond the ends of the roller a sufficient distance to provide bearings and attachment for the handles. Care should be taken to get the bar exactly in the center of the tile before placing concrete, and to keep it there while the concrete is being placed. Make a wet mixture of concrete and fill the tile with this mixture, up to the "bell" of the tile. Allow the concrete to set for ten days, when the roller may be placed on side, and the bell of pipe chipped off with a cold chisel and hammer. Attach a forked handle as shown in the illustration. As the axle is a firmly-fixed part of the roller, the fork ends of the handle must be provided with holes, within which the axle can turn.

A roller 18 inches in diameter and 2 feet long will weigh about 600 pounds. If a lighter roller is desired, use a smaller sized sewer pipe; or place several small pipes inside the large one, depositing the concrete around them on the outside. They will form hollow spaces inside the roller and lessen its weight.

By increasing the size of pipe, or by using a steel mold and attaching a pair of shafts or a tongue instead of a handle, horse rollers may be made for crushing the clods in the ploughed fields.

Cement lawn rollers are easily made



Cement culverts may be made square or round

Culverts and Small Bridges

Culverts or bridges of various size are necessary where highways must cross streams in order to take care of only the natural flow of streams, and to provide for flood periods in so far as possible. There is also often a demand for small bridges or culverts on farms where provision must be made to drive team or truck from one field to another where the two are separated by a stream.

The simplest form of cement culvert is that made of pre-cast cement pipe. Such a waterway opening is adapted to all opening requirements from 12 inches up to the largest size of pipe made, providing other conditions would permit the use of this type of waterway opening. Common practice limits the minimum size of waterway openings to 12 inches because smaller sizes so easily become choked with refuse or rubbish carried by the stream.

Next to the pipe culvert comes the box culvert. This is very simple to build because no complicated forms are needed and the cement work itself is simple. It is merely a long box or trough with cement sides, top and bottom and open ends or a small cement bridge in which the top slab acts as a floor to support the loads of traffic. The slab must be reinforced with steel rods or heavy steel mesh. Every box culvert should have a cement floor at the bottom to prevent damage to the entire structure from undermining by stream flow.

There are also culverts of the arch type in which the top is in the form of an arch instead of flat slab. There is no advantage in the arch culvert for small spans unless it is that the small arch requires no reinforcing because the concrete is placed in such shape as to take care of all load put upon it as compression. Naturally it is a little more difficult to build forms for arches than for box culverts.

When cement pipe are being laid for culverts, a carefully prepared trench should be dug, properly curved at the bottom so that pipe may be everywhere embedded at the required level.

Wing walls are usually provided on bridges and culverts to retain the road fill

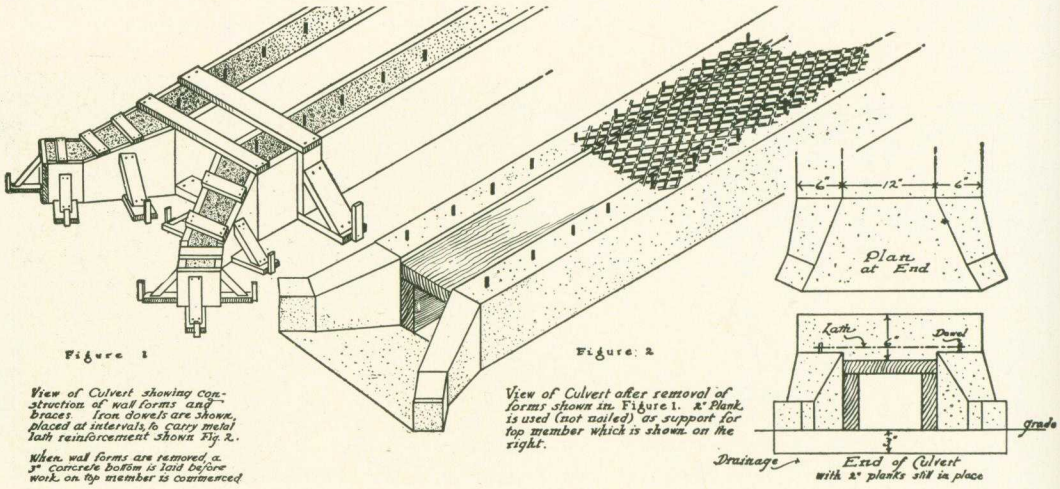
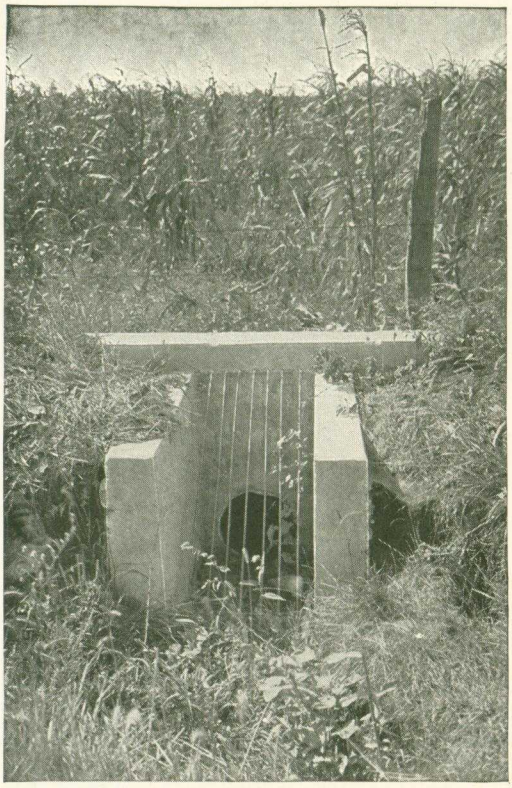


Figure 1
View of Culvert showing construction of wall forms and braces. Iron dowels are shown, placed at intervals to carry metal lath reinforcement shown Fig. 2.
When wall forms are removed a 3" concrete bottom is laid before work on top member is commenced
Figure 2
View of Culvert after removal of forms shown in Figure 1. 2" Plank, is used (not nailed) as support for top member which is shown on the right.
6"
12"
6"
Plan at End
Lath
Dowel
grade
Drainage
End of Culvert with 2" planks still in place

Methods of building another good style of square opening culvert



A screen will prevent rubbish filling a culvert or perchance its selection by some animal as a permanent home

and protect it against stream erosion. A culvert or bridge should, if possible, be installed at right angles with the road so as to make wing walls straight and parallel with the road. A vertical cut-off wall should be placed at each end of the floor in a box culvert extending down two feet into stream bed below the upper level of the floor as added precaution against undermining. In building small culverts the floor is usually made continuous with the walls and thus acts as a foundation. All culverts should have at least two feet of fill over them to help distribute traffic loads, unless, of course, the highway is paved with cement, in which case the top slab of the bridge or culvert is usually designed as a continuation of the highway pavement.

Many of the foregoing statements apply fundamentally to bridges. The term "bridge" is usually applied to a structure larger than one commonly called a culvert. Since every location requiring a bridge involves some different conditions than every other location, it is not possible to standardize bridge designs except within narrow limits of dimension. In other words, bridges that do not need to be more than 16, 18 or 20 foot span can be fairly well standardized so that almost any design for a small structure of this kind can be adapted to practically any location with but minor changes.

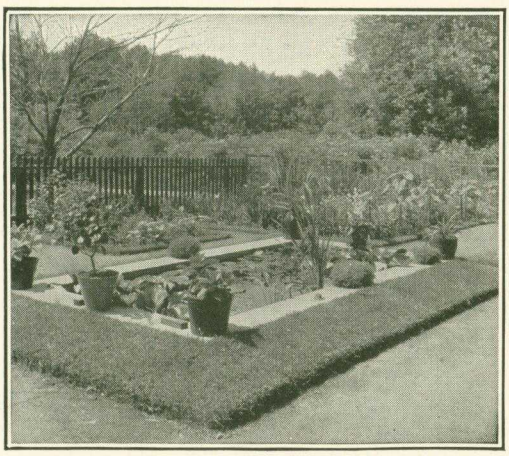
The flat slab bridge is probably the simplest form and is particularly suited to the short spans and loads of ordinary highway traffic. It is merely a cement slab of proper thickness, suitably reinforced and resting on abutments. Form work is simple.

Most highway departments have developed standard designs for small culverts and small bridges. From such designs one suitable for the bridge or culvert requirements of any location can usually be selected.

A very important precaution to take in connection with bridge construction is that forms shall be left in place until there is no doubt that the concrete has acquired the strength necessary to support the loads to which the bridge will be subjected when put in service.

Facts About Cement Roads, Streets and Alleys

At the present time the construction of cement pavements for roads, streets and alleys, is progressing at the rate of about 5,000 miles a year. Considering the fact that there are over two and one-half million miles of all kinds of roads in



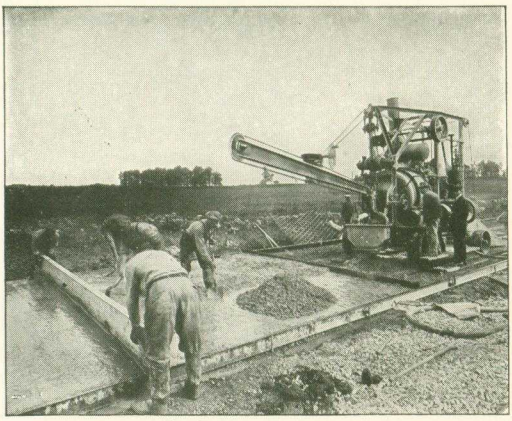
Cement pool for water-lilies

the United States, these figures may not seem very impressive. They have more importance, however, when one realizes that prior to 1920 the total of all cement roads in the United States built since the first road of that type was laid, amounted to only 10,787 miles. Also, it is only within the past two or three years that the building of really permanent roads has received its impetus.

The word pavement must be taken in its true sense and not confounded with the commonly used expression "hard surface." There are many types of hard surfaced roads, gravel, macadam and a variety of patented types, depending upon bituminous materials as a binder, etc. Most of these types have proved wholly inadequate to meet the demands of the changing traffic of recent years. The horse, which means the horse-drawn vehicle, has all but disappeared from our more thickly settled communities. Even the farmer keeps the horse mostly on the farm and makes his trip to town by automobile or motor truck. It is these vehicles that have transformed highway traffic and hence compelled new standards of highway construction. Wherever it has been used, and that means in all states of the Union, cement pavement is recognized as possessing more desirable qualities than are found combined in any other paving material. It is often referred to as the type of road having the maintenance built into it, and that this manner of referring to it is justified is proved by all figures covering highway maintenance cost for various types of construction. The cement road costs more to build than some other types but is worth more because first cost is not the sole criterion. Final cost is the test; and over a period of years the cement road has proved everywhere least expensive.

Scene on Bangor-Martins Creek, Pa., Cement Highway

ALPHA CEMENT — HOW TO USE IT

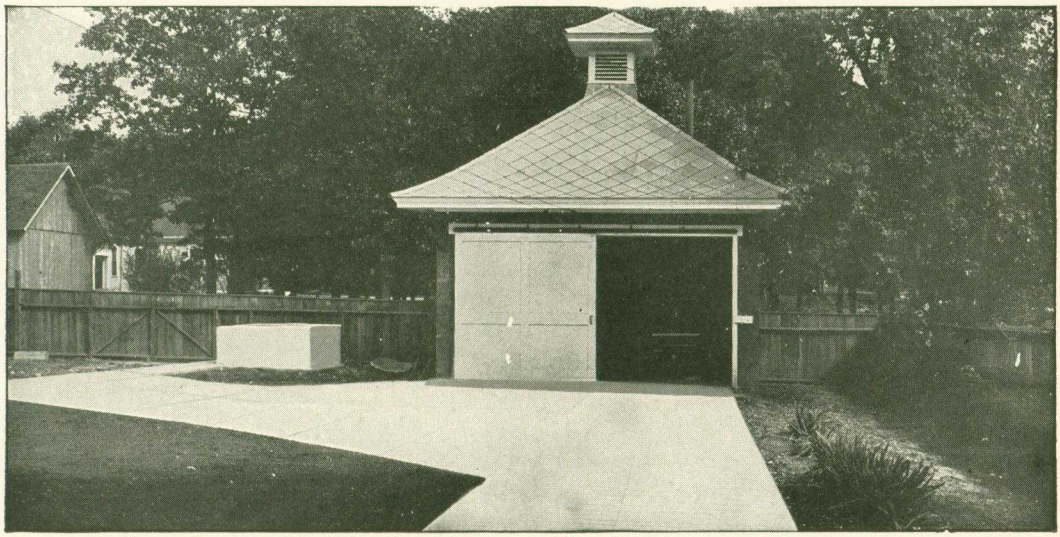


Laying a cement road

Construction costs as well as basic costs in every field have changed greatly in recent years. These changes however, have not affected the comparative cost of cement construction, since materials competitive with it have risen in cost also leaving concrete still in the same relative position with respect to its ultimate cost. In fact it has often been proved within the last year or so that even in first cost cement pavements can compete successfully with proven less durable types of hard surfacing.

A cement road is nothing more nor less than an extension of cement side walk designed to embody the qualities that will take care of the different requirements of vehicle traffic as compared with pedestrian traffic. Cement roads are thicker than sidewalks, are often reinforced, should be built from 18 to 20 feet or more in width, depending upon the volume of traffic to be provided for, should be laid with particular care to the most highly developed drainage of the subgrade possible, and particular care should be given to selection of materials, proportioning, mixing, placing, finishing and curing the concrete. It is not possible with any other type of construction to produce a road surface having the evenness, skidproof texture of surface and permanence that result from the use of concrete laid according to the Standard Specifications for Cement Road, Street and Alley Construction.

Just as cement possesses superior qualities as a road paving material, so does it display the advantages of these qualities in street and alley paving. It is comparatively low in first cost, clean, dustless, maintained at trifling expense, sanitary, skidproof—the safety-first pavement. It is not affected by extremes either of heat or cold. The surface is so dense and impervious that cement pavements require but little crown to insure quick free drainage. Therefore, all of the paved area may be used by vehicles with equal safety. Nothing has to stand harder wear than roads. Cement construction has all the qualities that resist wear and hard usage. That is why the cement road is increasing more rapidly than any other type of so-called pavement highway.



Cement driveway with platform for washing automobiles. Note the cement garbage box at the left

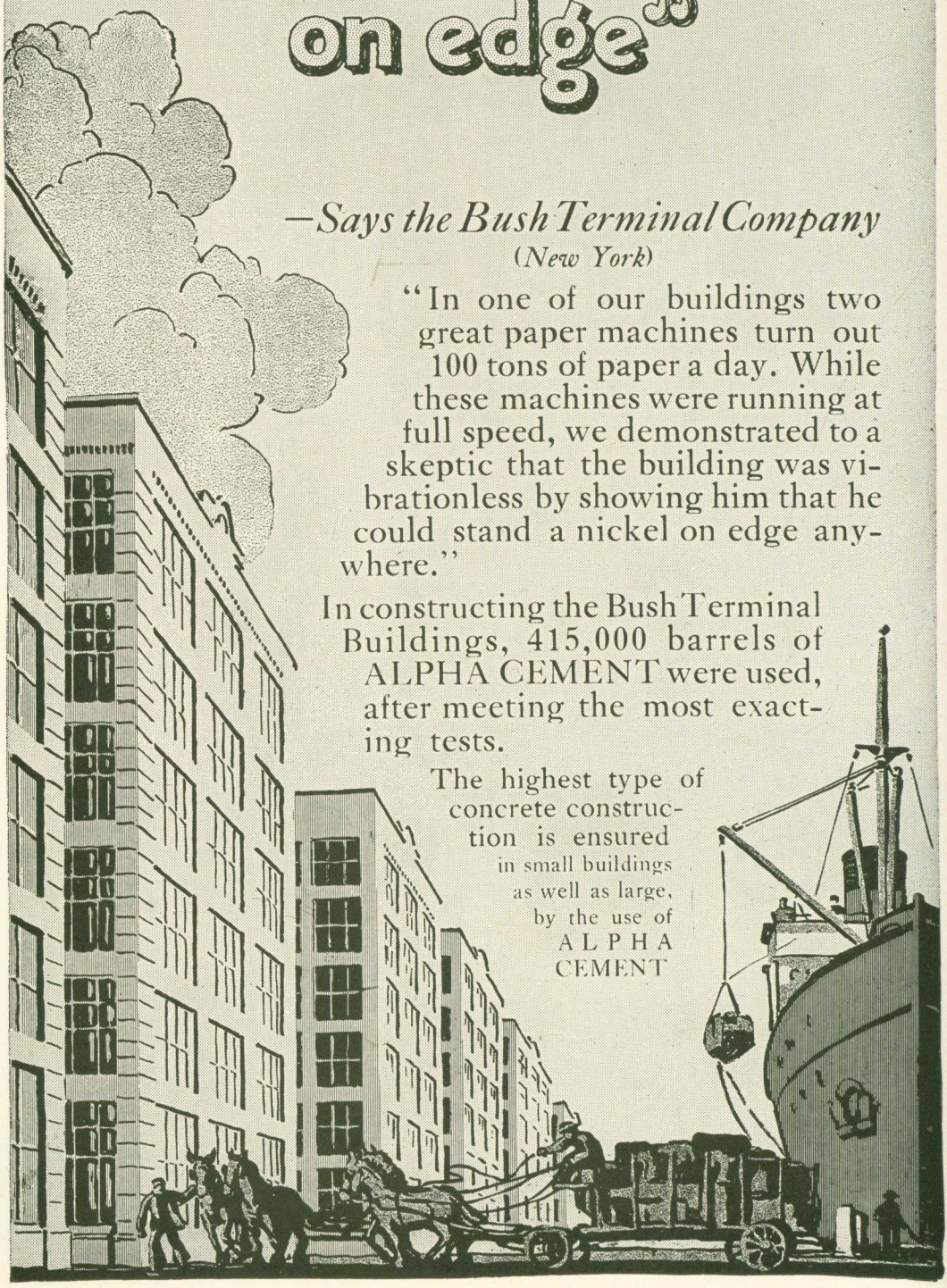
"Could stand a nickel on edge"

—Says the Bush Terminal Company
(New York)

"In one of our buildings two great paper machines turn out 100 tons of paper a day. While these machines were running at full speed, we demonstrated to a skeptic that the building was vibrationless by showing him that he could stand a nickel on edge anywhere."

In constructing the Bush Terminal Buildings, 415,000 barrels of ALPHA CEMENT were used, after meeting the most exacting tests.

The highest type of concrete construction is ensured in small buildings as well as large, by the use of ALPHA CEMENT



ALPHA CEMENT — HOW TO USE IT

Standard Specifications

Special Note—The testing of cement is often entrusted to persons not thoroughly qualified by long experience to appreciate the many idiosyncrasies that the material seems to display under varying conditions. Cement testing should be entrusted only to persons qualified through complete knowledge of the chemical properties of the ingredients entering into its composition and experienced with all processes of preparation and handling of these materials through the various stages of manufacture necessary to produce the finished product known as Portland Cement.

Definition—1. Portland cement is the product obtained by finely pulverizing clinker produced by calcining to incipient fusion, an intimate and proper proportioned mixture of argillaceous and calcareous materials, with no additions subsequent to calcination excepting water and calcined or uncalcined gypsum.

I. Chemical Properties

Chemical Limits—2. The following limits shall not be exceeded:

Loss on ignition, per cent.....4.00
Insoluble residue, per cent.....0.85
Sulfuric anhydride (SO), per cent.....2.00
Magnesia (MgO), per cent.....5.00

II. Physical Properties and Tests

Specific Gravity—3. The specific gravity (the specific gravity test will not be made unless specifically ordered) of cement shall not be less than 3.10. Should the test of cement as received fall below this requirement, a second test may be made upon an ignited sample.

Fineness—4. The residue on a standard No. 200 sieve shall not exceed 22 per cent by weight.

Soundness—5. A pat of neat cement, after 24 hours in moist air, when immersed in steam, shall remain firm and hard, and show no signs of distortion, cracking, checking or disintegration.

Time of Setting—6. Initial set shall develop in not less than 45 minutes when the Vicat needle is used or 60 minutes when the Gillmore needle is used. Final set shall be attained within 10 hours.

Tensile Strength—7. (*a*) Test pieces of standard mortar composed of one part cement and three parts standard sand, by weight, shall give tensil strengths equal to or higher than the following:

Age at Test Days	Storage of Test Pieces	Tensile Strength lb. per sq. in.
7	1 day in moist air, 6 days in water	200
28	1 day in moist air, 27 days in water	300

(*b*) Each value shall be the average of the results of tests from not less than three test pieces. The tensile strength of standard mortar at the age of 28 days shall be higher than the strength determined at the age of 7 days.

III. Packages, Marking and Storage

Packages and Markings—8. The cement shall be delivered in suitable bags or barrels bearing the brand and name of the manufacturer, unless shipped in bulk. A bag shall contain 94 lbs. net. A barrel 376 lbs. net.

Storage—9. The cement shall be stored in such a manner as to permit easy access for proper inspection and identification of each shipment, and in a suitable weather-tight building which will protect the cement from dampness.

IV. Inspection

Inspection—10. Every facility shall be provided the purchaser for careful sampling and inspection at either the mill or at the site of the work, as may be specified by the purchaser. At least 10 days from the time of sampling shall be allowed for the completion of the 7-day test, and at least 31 days shall be allowed for the completion of the 28-day test. The cement shall be tested in accordance with the methods herein prescribed. The 28-day test may be waived if ordered.

V. Rejection

Rejection—11. The cement may be rejected if it fails to meet any of the requirements of these specifications.

(*a*) Cement shall not be rejected on account of failure to meet the fineness requirement if upon retest after drying at 100° C. for one hour it meets this requirement.

(*b*) Cement failing to meet the test for soundness in steam may be accepted if it passes a retest using a new sample at any time within 28 days thereafter.

(*c*) Packages varying more than 5 per cent from the specified weight may be rejected; and if the average weight of packages in any shipment, as shown by weighing 50 packages taken at random, is less than that specified, the entire shipment may be rejected.

Cement in Land Drainage

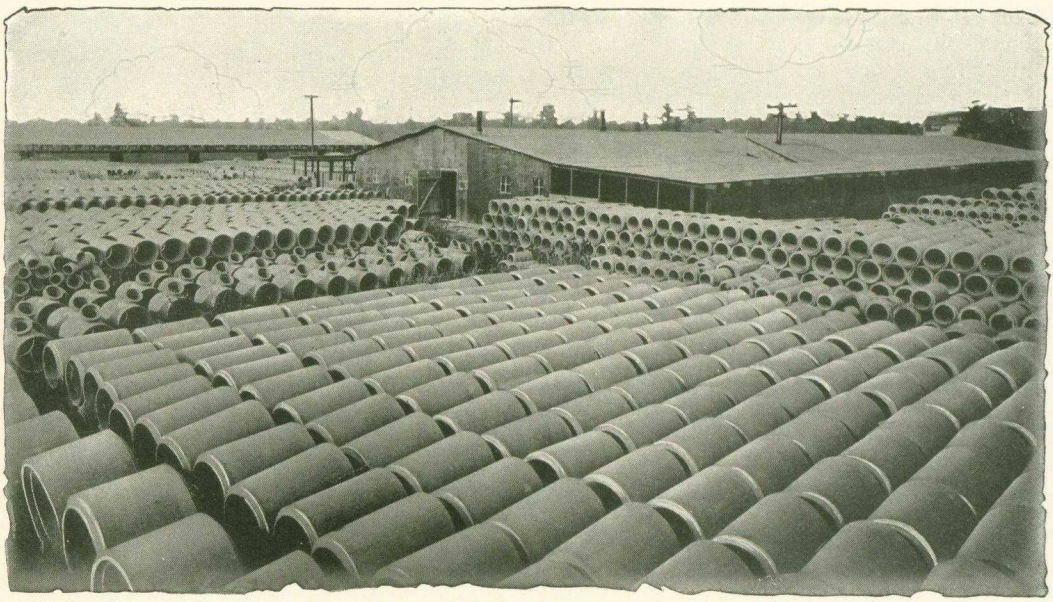
Many millions of acres of land which for a greater portion of the year are little better than a swamp are being made productive by systematic drainage. In this work cement is playing an important part, for cement drain tile are regarded as the high quality product in this field. Drainage is also helping to restore the productiveness of many acres of land in different parts of the country which have become more or less water-logged due to continuous irrigation over a period of many years.

Drainage opens up and aerates the soil and keeps it in better condition for crops. There are many examples of cement pipe and tile drains in existence 50 or more years old and which so far as the cement itself is concerned are still in perfect condition, giving evidence that cement pipe and tile possess in the highest degree the durability necessary to such a permanent improvement as land drainage.

From time to time, however, one hears that cement pipe or tile will not withstand the action of alkali or certain soil acids. It is true that many cement tile have been found almost completely disintegrated, but causes for such disintegration are now so well known that there is plenty of proof at hand to refute any statements that such cement products are not suitable for land drainage. Where disintegration of cement tile in use has been noted, the causes have generally been definitely fixed as due to the use of a mixture too lean in cement, or too dry a mixture, or to failure to properly cure the finished product after removal from the molds. Also, the tile should not be placed in the ground until at least 30 days old.

One marked characteristic of cement tile, properly made, is their ability to resist frost action or alternate freezing and thawing conditions. Most of the early failures in cement tile, which have been used as the subject for many unwarranted statements as to their lack of durability, occurred because those first engaged in the tile manufacturing industry were not willing to recognize and to apply those fundamentals well known to lead to success.

By far the greatest quantity of cement tile used range from 4 to 10 inches in diameter, so on account of the thickness of tile walls, it is not practicable to use sand or other aggregate in which the particles exceed ¼ inch. If the tile or pipe has walls of sufficient thickness to permit using a larger aggregate, then the maximum size may range up to ½ inch, provided the entire bulk of ingredients is so proportioned and



Stock of machine-made cement pipe in manufacturer's yard. These pipes were used in the sewer system of America's largest army cantonment, Camp Lewis, Washington

graded as to produce a dense concrete. For drain tile up to and including 10 inches in diameter, concrete should be mixed in the proportions 1:3. For drain tile over 10 inches in diameter in which coarse aggregate having a maximum size of particles of ½ inch is used, the mixture should consist of 1 sack of Portland cement to not more than 5 cubic feet of fine and coarse aggregate measured separately, but in no case should the mixture contain more than 3 cubic feet of fine aggregate to each sack of cement used. It is recommended that those interested in complete details of cement tile making write us for Standard Specifications covering the manufacture of this product.

Except in sizes of 12 inches in diameter and above, it is not practicable to make tile by the hand-tamp process nor is it practicable to make the smaller sizes such as are used in greatest quantity for land drainage by the so-called poured process. The tile should be made by machine, of which there are several approved types on the market.

To be of good quality, drain tile should show a low percentage of absorption. Sufficient water should be used in properly proportioned mixtures so that when the tile are removed from the machine the exterior surfaces will show web-like markings indicating flushing of a slight excess of water to the surface. As with other cement products, proper hardening is very important and of the various methods steam-curing is to be preferred. The manufacture of cement tile is not recommended to the home worker in concrete. It is a process requiring thorough appreciation for, and application of, simple, yet important fundamentals. The use of equipment in the form of a machine, the expense of which the average farm could not justify and above all facilities for steam curing the product, are other details which the home worker cannot arrange to provide. For this reason those intending to use cement tile should make it a point to patronize a reputable plant turning out this product.

Cement Sewers and Cement Sewer Pipe

Probably no municipal work calls for better or more durable construction than a sewer system. It is for that reason that concrete, both in the form of monolithic construction and cement pipe is used so extensively in sewer work. Other materials also are used but there is no doubt that a very large majority of sewers in all cities of the country have involved the use of concrete more extensively than of any other material.

Very large sewer mains, such as used for the principal channels of extensive city sewerage systems are often built of monolithic construction, the design of such sewers being an engineering proposition. However, very large cement sewers are made of cement pipe because advance accomplished within recent years in the manufacture of this product has been wonderful. At the present time between two and three hundred cities in the United States use cement pipe exclusively for sewers.

Many types of cement sewer pipe are manufactured. These differ, however, principally in the methods used to form joints and in the manner of reinforcing the pipe. Some types are circular, some oval, some combined oval and flat sections. Some pipe are hand made and some are made by machine. Various methods, some of which are patented, are used to form joints. Some pipe have bell and spigot ends, others have plain ends which interlock in various ways, usually provided for when the pipe are manufactured. Regardless of form or shape, the value of cement sewer pipe, like any other cement product rests largely in its quality. This is dependent entirely upon observing proven requirements of manufacture. No compromise should be made in the matter of correct proportions, clean, well graded materials and proper consistency of concrete, and finally, proper curing of the finished product.

Sewer pipe of large size, especially those above 24 inches in diameter are usually manufactured by the hand-tamp process often at the site of the work and in special forms provided for the purpose. These usually consist of properly shaped steel plates with the inner form so placed within the outer one that the shell of the finished pipe will be of the desired or required thickness.

The concrete mixture used in the manufacture of sewer pipe should never be leaner than 1:2:4. In order that the concrete mixture may be properly handled in the

manufacture of reinforced cement pipe by hand, coarse aggregate should not exceed ¾ inch in greatest dimension for pipe with shells 4½ inches and less in thickness. Where shell thickness is greater, coarse aggregate up to 1½ inches may be used, but owing to the position of reinforcement and the methods by which some types of joints are formed, it will generally be found best to confine aggregate to a maximum of one inch in size.

Further details for manufacturing cement sewer, pressure and culvert pipe, all three of which are essentially alike, will be found in "Suggested Specifications for Plain and Reinforced Concrete Pipe," which we shall be glad to send to anyone interested.

Cement in Irrigation

Those of us who are in the habit of living where rainfall is frequent and ample for all crops usually grown, can hardly appreciate the money value which water has in many sections of the arid west. In those sections, water is really a marketable commodity, and millions of dollars have been expended in building huge storage reservoirs of which cement dams are a feature, merely for the purpose of conserving water so it may be distributed where and when most needed for irrigation. Many of the so-called reclamation projects which have been carried on by the U. S. Government have made available for agricultural pursuits millions of acres of land saturated with fertility but which could not contribute that fertility to agriculture because of limited or no rainfall in the part of the country in question.

With such a value placed upon water in these arid and semi-arid sections, every means is used to conserve local resources, and in that conservation cement has long played an important part. The loss of water through seepage in earth canals is very great. Wood linings were used at one time quite largely to prevent these seepage losses but timber was expensive and short lived and for this reason proved inefficient because involving high cost of maintenance. Now, no irrigation project is planned or put into operation without making extensive use of concrete to line main canals and laterals. In some cases underground cement pipe lines operate in place of open ditches. Even though the flow area of ditches is lined with concrete, there is nevertheless often considerable evaporation of water in transit. Where such losses are great, it is desirable to prevent them as well as seepage losses.

The Portland Cement Association has published a booklet entitled "Concrete for Irrigation Canals" which sets forth at greater length the various advantages of concrete in this field of use and the many pictures in this booklet illustrate how extensive that use has been. Certain details of construction are shown and methods of construction described. We shall be glad to send a copy of this booklet to anyone interested.

Cement in Mines

Cement has long been used extensively in mine workings both above and below ground. In any mining operations, underground fire particularly is always to be dreaded. Liability of fire is greater in some classes of mines than others, notably in coal mines, but in any event precautions must be taken against fire because of the probable loss of life that would follow the burning of underground structures. The word "structures" in this sense is used to refer to mine props, shaft linings and hoisting stations or any other workings where timber has been and formerly was the material most used to keep the portions of the mine being worked from caving or falling in.

In most mines the conditions of the atmosphere with particular reference to dampness are ideal for the rapid rotting of timber. At one time timber was preferred as a material for all underground as well as above ground structural purposes in mining operations. There was a logical reason for this since in most mining sections in the early days the surrounding country was well covered with timber. Therefore such material was right at hand and cost practically nothing. However, its short life in use made the maintenance high, and in the end timbering proved most expensive. Many disastrous fires also pointed to the wisdom of preventing a recurrence. The result was a gradual turning to cement which in recent years has been followed by most wonderful development of the use of cement in mines. Shafts are now completely concrete lined, underground timber-

ing is all of concrete, tunnels are lined either with monolithic concrete or by a layer of concrete of varying thickness applied by means of a cement gun or similar apparatus, and all structures above and below ground on a mining property that promises long time operation are made permanent, maintenance free and proof against fire by exclusive use of concrete.

Valuable Bulletins of the Portland Cement Association

The Portland Cement Association, of which the Alpha Portland Cement Company is a member, issues a number of valuable treatises that are supplied free of charge to those interested. In the belief that many of these documents will be of particular interest to readers of this Handbook, the following list is printed:

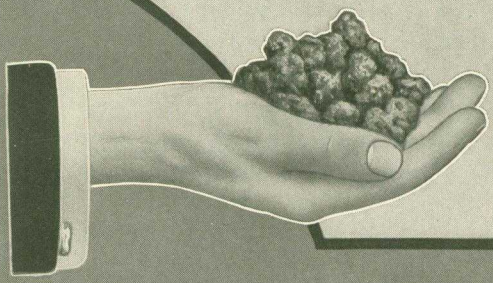
R–1 Specifications for Concrete Roads, Streets and Alleys
R–2 Recommended Practice for Concrete Road and Street Construction
R–3 Facts About Concrete Roads
R–4 Concrete Streets for Your Town
R–5 For Your Alley—Concrete
R–6 Maintenance of Concrete Pavements
R–7 Curing Concrete Pavements Laid in Warm Weather
R–8 Integral Curb for Concrete Pavement
R–9 Concrete Industrial Driveways
R–10 Some Facts About Concrete Roads
R–12 Concrete Highway Grade Crossings
R–13 Effect of Water on the Strength of Concrete
R–18 Concrete Pavement For Car Track Zones
R–21 Precautions for Concrete Paving in Cold Weather
S–1 Mercantile and Industrial Buildings of Concrete
S–5 Concrete Schoolhouses
S–6 Concrete Hotel, Apartment & Office Buildings
S–11 Concrete Highway Bridges
S–13 Concrete Railway Track Support
S–14 Concrete Chimneys
T–1 Concrete Tanks for Industrial Purposes
T–2 Concrete Tanks for Fuel Oil Storage
T–3 Concrete Swimming and Wading Pools
T–8 Recommended Practice for Portland Cement Stucco
T–9 Standard Specifications and Tests for Portland Cement
C–1 Concrete Tile for Land Drainage
C–3 Concrete Pipe Sewers
C–4 Concrete Linings for Irrigation Canals
F–1 Concrete Silos—Monolithic and Block
F–2 Cement Stave Silos
F–4 Concrete Grain Tanks
F–6 Concrete on the Hog Farm
F–9 Concrete Septic Tanks
F–14 Concrete on the Dairy Farm
P–1 Concrete Building Block and Brick
P–3 Concrete Block Garages
P–5 Concrete Fence Posts
M–1 How to Make and Use Concrete
M–5 Making Winter Months Pay
M–7 Storage of Sacked Cement
M–9 Concrete Stave Coal Pockets

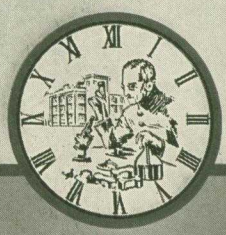
Address:
PORTLAND CEMENT ASSOCIATION,
111 W. Washington St.,
Chicago, Ill.

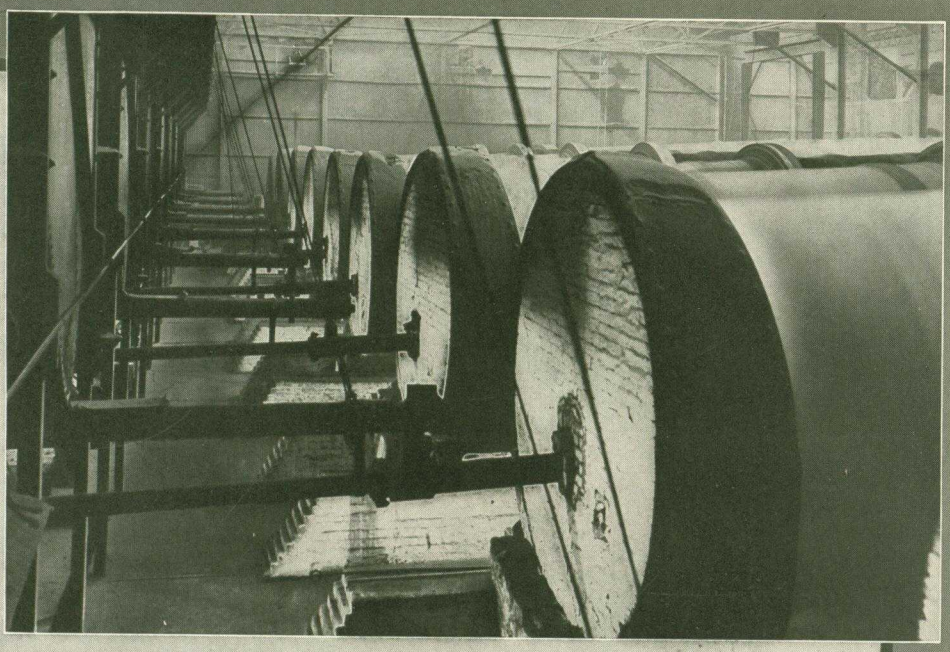
A BOOK several times the size of this one could be filled with descriptions of scores of other useful cement improvements. Therefore, many improvements are not treated in detail in these pages but are covered by the Alpha Special Bulletins and Service Sheets, a partial list of which will be found on the inquiry cards inserted in the back of this treatise.

1 This illustration shows the great Martins Creek quarry of the Alpha Portland Cement Company just after the 10½-ton dynamite blast. At regular intervals, during the boring of the blasting holes, a sample of the rock was taken for preliminary analysis. These analyses are made by chemists whose duty it is to keep constant and strict watch over the quality of ALPHA CEMENT. This care begins with the boring of blasting holes and continues through every step of ALPHA CEMENT manufacture —always under the trained eye of chemists.

3 After having been thoroughly burned in the great rotary kilns for about one and three-quarter hours, the materials of which ALPHA CEMENT is made come out in the form shown here—a gray clinker. This clinker, when cool, is subjected to the second grinding process, and this time the grinding is so fine that the finished product will more than meet the standard requirement: that 78 per cent. will pass a sieve having 40,000 holes to the square inch. The cement is then largely an impalpable powder, so fine that when properly mixed it makes a paste that coats the sand and stone of the concrete thoroughly.

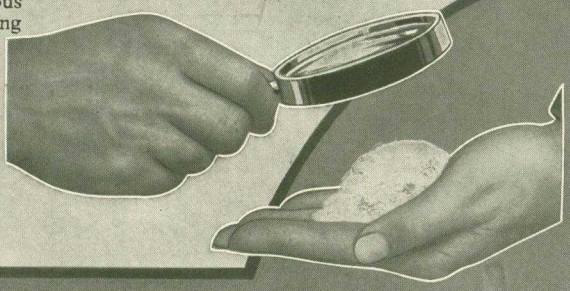


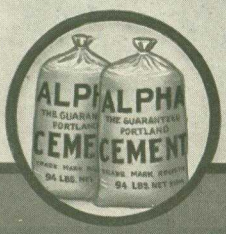


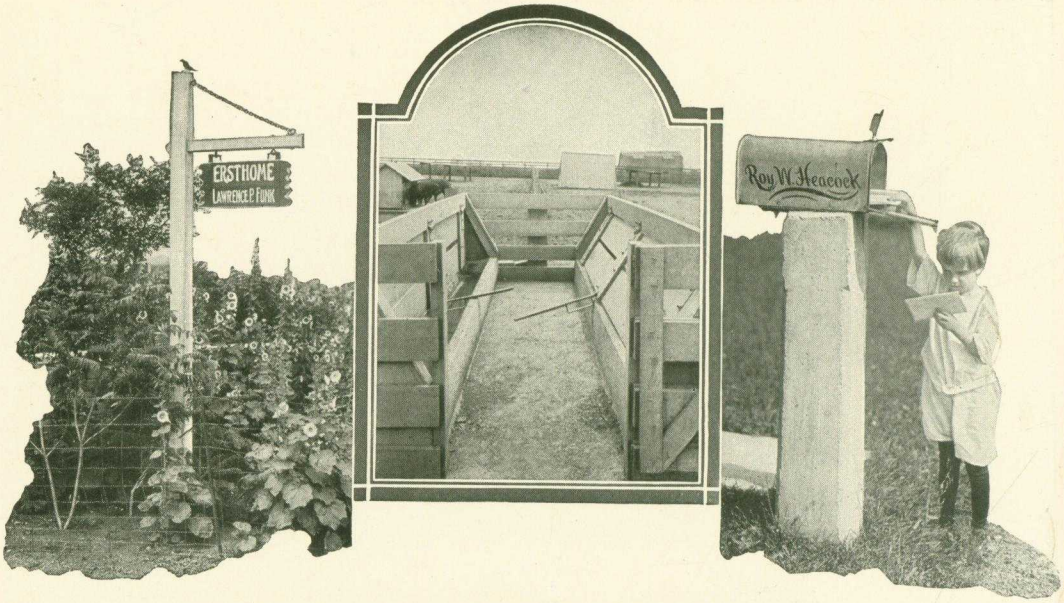


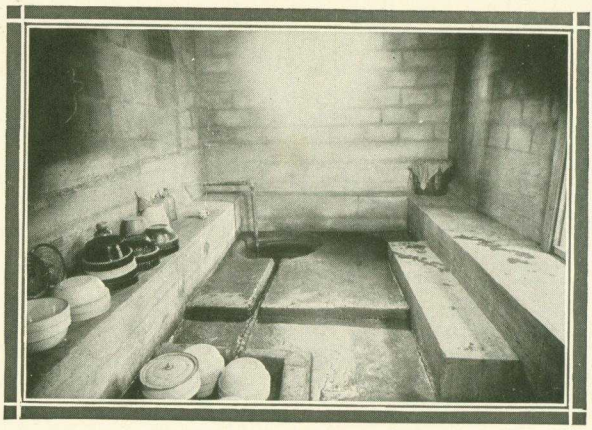
2 When the raw materials for ALPHA CEMENT have been proportioned with great care, and the mixture has been dried and ground finely, the powder is conducted into the high end of the great kilns shown above, which are 140 feet long. Here the material is subjected to intense heat, created by a flaming blast of finely powdered coal—the temperature running 2,500 to 3,000° F. in the burning zone of the kiln. As the kilns slowly revolve, the powder travels downward. The entire burning and grinding operation is supervised by chemical and efficiency engineers in all ALPHA plants.

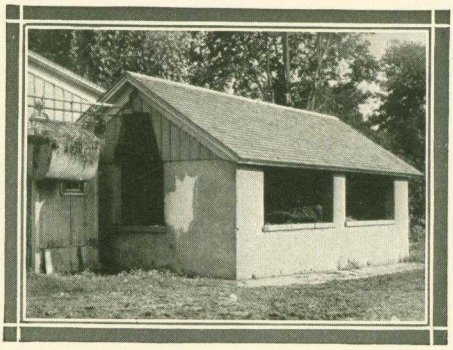
4 ALPHA CEMENT can always be depended on for uniform fineness. If you will use the microscope on a handful of ALPHA you will see no underground particles to lower the binding power, but a smooth, flour-like powder that can be counted on for first-class results. Chemists are real bosses in all ALPHA CEMENT plants, and no zeal for large output or low operating cost can alter their decisions. All ALPHA CEMENT is of one grade—the best that a quarter century of experience and the most modern equipment can produce from quarries that are famous in the cement-making world.

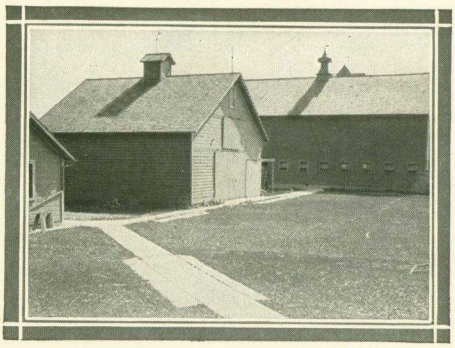




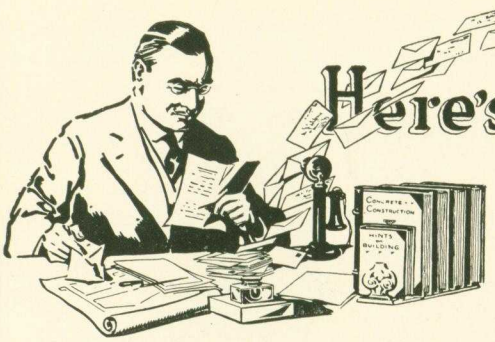




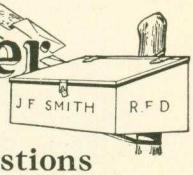




A few more useful suggestions on cement improvements. The barnyard scene shows that one farmer not only recognizes the value of cement walks, but knows how to protect them against damage where the roadway crosses the walk. The hog trough design shows how the hogs can be kept out of the trough while their food is being put on the table, as it were. The covered manure pit shows a type much like that advocated on page 84. The spring house interior shows the convenience of a solid cement shelf around the entire room



Here's That Answer



to a number of questions about cement construction that come up frequently

Where gravel must be hauled, and good sand is on the ground, does it not pay to use cement and sand exclusively? I must pay for all my hauling. How does a sand and cement mixture compare with a mixture of cement and graded gravel in strength?

IT will require much more Portland Cement to make concrete of just sand and cement than it would if stone, sand and cement are used; and stone adds strength that sand cannot supply. Strictly speaking, the result is not concrete unless some material coarser than ordinary sand is used. Concrete, as the word is ordinarily understood, refers to some kind of coarse aggregate such as crushed stone, gravel, cinder, hard slag, etc., knit together by a mortar of sand and cement. The office of the sand and cement is to fill the voids in the coarser material and to knit the entire mass together in an everlasting bond. Cement is the most expensive material used in the making of concrete, and good sand, when the job is a large one, represents considerable money. Therefore, to eliminate the coarser material will not only mean weaker concrete but ordinarily will greatly increase the cost. Even if hauling expense has to be incurred, we recommend that this inquirer use a mixture of one part cement, three parts of coarse, clean sand, and five parts of clean gravel rather than to do his work with a mixture of one part cement to four of sand, which is as lean a mixture of sand and cement as would be advisable. Concrete that contains too much sand will "dust off," especially if considerable of the sand is fine. It is always desirable to have sand that has a good proportion of coarse grains.

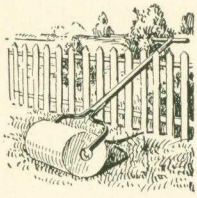
Sometime ago I put a cement floor in my stable and it has turned out to be very satisfactory, with the exception that it is rather slippery. Can I do anything to correct this fault?

Your floor may have been smooth-troweled, which is not good practice for cement surfaces that are to afford a safe footing for animals. Or possibly the grade from center to sides is too sharp. If the rise is not more than one inch in six feet, the following treatment is suggested:

Get a heavy steel hammer with a face similar to that of a shingle hatchet—that is, the face of the hammer should have the appearance of a series of pyramids, with the points approximately ½ inch apart. Chip the surface of the concrete with this hammer. The floor will then likely be rough enough to obviate the danger of slipping and it will be unnecessary to add a top coating.

If your floor has a grade or rise of more than one inch in six feet and it is deemed necessary to regrade it, first roughen the surface as above indicated. Then give the floor a thorough sweeping or washing, so as to get off all the particles of chipped concrete. After this wash the floor with clear cement and water. While this is still damp, apply a 1:2 mixture, that is, 1 part of cement to 2 parts of good clean sand. This coat should be at least one inch thick in the thinnest place and the sides as much thicker as is necessary in order to bring the floor up to the required grade. While this coat is still soft, brush it with a coarse, stiff brush or broom so as to make a rough surface.

ALPHA CEMENT — HOW TO USE IT



How can concrete be made to knit together firmly when the work is done at different times?

It is always best to arrange to have the surface or finishing coat of concrete placed before the other concrete has fully set; then there will be no trouble about getting a good bond. However, when it is necessary that a facing or extra coat of concrete be added, after the completion of the other work, the surface on the old concrete should be thoroughly cleaned, using for this purpose a solution of one part muriatic acid to three or four of water. Let this wash stay on the surface until the concrete has been etched away enough to expose the rough aggregate. In this way, the new concrete will have something on which to get a grip. Before applying the fresh concrete, flush off the rough surface of the old concrete with clean water so as to remove the acid thoroughly and keep the surface thoroughly wet until the new concrete is applied. For such work, a mix of one part cement and two of sand will give the best results.

Often, when I am trying to get a nice, smooth wall, I find that pockets have been left in the concrete, and this makes the surface look unsightly when the forms are taken away. How can this be remedied?

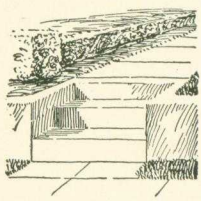
The best way to remedy this fault is while the concrete is being placed. In the first place, the mixture should be mushy enough to pack down solidly and care should be taken to see that the larger stone used in the work is mixed well up with the smaller. But even when this is done, it is best at frequent stages of the work, to take a spade or other flat tool, and work this down between the fresh concrete and the outer form. This will shove the larger stone away from the extreme edge and permit the fine material to work outward. It furthermore aids in making your concrete more dense, which is very important where the wall is expected to repel water.

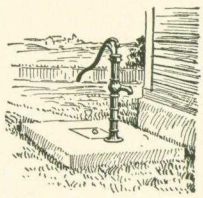
What is the best way of preventing cracks in pavements and driveways?

Probably ninety per cent of all cracks in pavements and driveways are caused by the action of frost. The remedy is a deep, well laid and well drained subbase composed of material such as cinders or ashes that will not expand in freezing.

Cracks come frequently from the neglect to provide for expansion and contraction. Concrete that is exposed to heat and cold is subject to a certain amount of contraction and expansion. The expansion joint should not be a mere ornamental line on the surface but should extend down through the slab. Some contractors provide for this by first laying only every other slab. When the first slabs are hard, the empty spaces are filled.

Fine or "hair" cracks are usually caused by too much fine sand or by excessive troweling before the cement has taken its initial set; the troweling brings the cement and fine material to the surface. Give the cement time for the initial set before beginning the final troweling. Hair cracks do not extend deep and do not ruin the walk but mar its appearance.





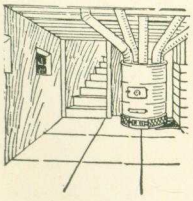
A few months ago I put a cement cellar wall in a house that I was building at that time. During the last week we have had some heavy rains and the water has leaked in. Is this the fault of the cement or poor mixing?

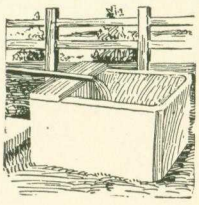
Your concrete was probably lacking in density.

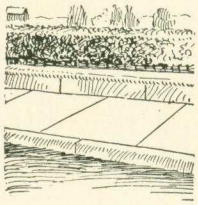
Numerous tests by various scientific bodies as well as by the Bureau of Standards of the U. S. Government have shown that the best way to secure a waterproof concrete is so to grade your aggregates

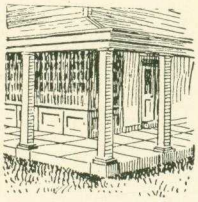
as to secure the densest possible concrete. By this is meant, use stone and sand, the particles of which are varied in size so that the spaces between them when they are mixed together will be a minimum. A concrete made of aggregates graded in this way in which sufficient water is used to make a mushy mass and which, when placed in the forms, is well tamped and spaded, will generally be waterproof, that is, unless the wall is thin. By spading is meant shoving a thin, sharp-edged tool down between the concrete and the forms and also shoving it down into the center of the mass while it is being placed. This forces the larger stones back from the face of the concrete, and allows a mixture of rich grout to come to the exposed surface of the work, and releases bubbles of air in the center of the mass that would otherwise leave hollow spaces. Additional density can be secured by painting the surface of the concrete. (See page 31.)

It is very difficult, where a wall has already been built and found to be porous, to correct the trouble from the inside. It can be done by building an extra 4-inch wall with an open space of from 1 to 1½ inches between that and the old wall and providing a way for the water to flow out from this space into a drain; or by applying pitch and felt and an extra wall or layer of dense concrete, but by this method the floor must be a continuous, dense slab of concrete, otherwise the water will find its way under the floor and come up through that. Correction from the inside is troublesome and costly. It is better to get at the leak from the outside and by the application of tar and felt, a waterproofing compound or by a supplemental wall or mass of dense concrete on the outside, to keep the water away from the porous wall. As a matter of precaution, a drain should also be laid.









What is a simple rule for determining the amount of cement required by a certain proportion?

The following rule is one used by some contractors in getting a quick, general estimate of the cement required: Divide the total of the figures representing the proportions into 11 and use the result as the number of barrels of cement needed for a cubic yard of concrete. To illustrate: The proportions are 1:3:6; the total of 10 divided into 11 gives 1 1-10 as the number of barrels of cement required for each cubic yard of the volume to be filled. This rule gives approximately correct results.

During September, when we had some very cool nights, some concrete that I had in forms looked as if it were not going to set at all. I complained about the cement but let the forms stay and a week later the concrete was as hard as a rock. Can you explain this? I am sure the concrete did not freeze much, if any.

The following extract from the *Engineering News* answers this question well:

"The fact is that while most constructors realize that concrete will not set in freezing weather, many do not appreciate that from 45° F. down to freezing there is a definite slowing up of the setting, which is actually more dangerous than a complete failure to set. Anyone ought to be able to recognize a frozen concrete; it takes a much higher degree of skill to determine a working-strength set.

"During the later fall, in most parts of this country, night temperatures will be hovering around freezing, although in the daytime artificial heating of the concrete will rarely be required. In consequence, much concrete from which normally the centers could be removed in two or three weeks, will be so retarded in

set as to be dangerously near failure, unless supported for a week or two weeks beyond the standard period. If the discouraging records of all the autumns of the last ten years are not to be repeated, every man responsible for the laying of reinforced concrete will study his thermometer during October and November and be quick to protect his forms when the temperature gets into the forties."

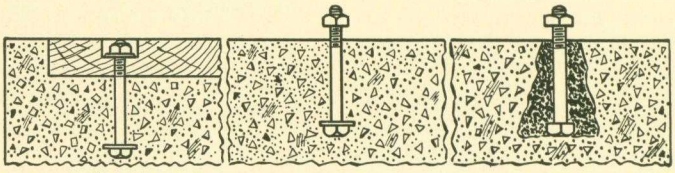


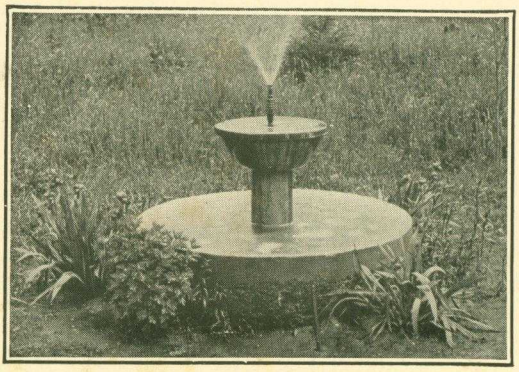
FIG. 1 FIG. 2 FIG. 3

I intend to put a cement floor in a small power house in which will be installed a gasoline engine that will be used for pumping, running cream separator, etc. How can I lay the floor so as to provide for bolting the engine down firmly?

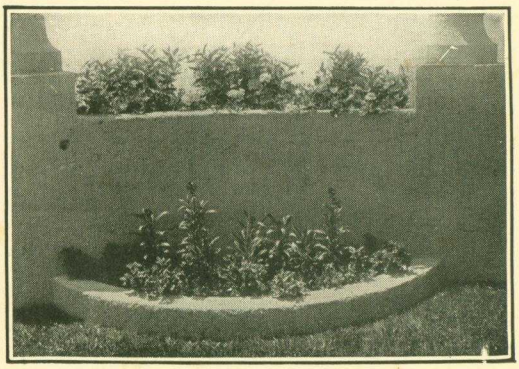
There are two ways of doing this: one is to anchor pieces of hard wood, say 4 in. x 4 in. timber in your concrete in the manner shown in Fig. 1, where the timber is set flush with the floor and is countersunk for a nut and washer.

The other would be to set the anchor bolts in the concrete permanently (see Fig. 2). This can be done by making a wooden template of the base of the engine (a frame that will accurately locate all bolts and suspend them in position); place this template in the position desired and fix the anchor bolts in the template at a proper distance above the floor.

If the cement floor is already laid and you desire to anchor a gasoline engine to it, holes can be drilled in the concrete, as illustrated by Fig. 3, and anchor bolts securely fastened by lead, melted sulphur, or a rich cement grout. These holes can be drilled with an ordinary hand drill such as is used for drilling rock. Be sure the holes are drilled deep enough to give you a secure fastening for the engine, then place the bolts in the holes so that they extend at a proper distance above the floor, and pour lead, melted sulphur or rich grout around them.



Cement bird bath of simple construction



Use of cement in making flower beds

CARD No. 1

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Easton, Penna.

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Milk House
Ice House
Manure Pit
Septic Tank
Oil Storage Tank
Tennis Court
Inclosure Walls
Barn and Silo
Public Comfort Stations

Corn Crib
Poultry House
Smoke House
Hog House
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The ALPHA SERVICE SHEETS are now available on the subjects named on these mailing cards. In issuing these Service Sheets it is not our desire to supplant the architect or the contractor, but rather to supply fundamental information that will be helpful in suggesting new, better and more lasting ways of building.

CARD No. 1

If you have not already received ALPHA BLUEPRINT SERVICE SHEETS relating to the improvements you are now planning, ask your dealer for them—or, if you prefer, check the subjects which interest you on Card No. 1, sign your name and address and mail it to us at once. We will send you postpaid, the information asked for.

CARD No. 2

If you have a neighbor who is thinking of building anything named on the list below, hand him Card No. 2. With it he can send for a free copy of our book "ALPHA CEMENT—How to Use It" and Service Sheets that will help him to build the improvements he contemplates. You surely know of someone who will be glad to get this valuable aid. He will thank you for the hint.

CARD No. 2

HAND THIS CARD TO A NEIGHBOR IF HE IS PLANNING CEMENT WORK

ALPHA PORTLAND CEMENT CO.
Easton, Penna.

This card was given to me by.....

I am planning to build.....

Please send me a copy of the book "ALPHA CEMENT—How to Use It" and the ALPHA Service Sheets showing how to construct the improvements I have checked below:

Workingmen's Homes
Walkways and Driveways
Cement Roads
Bridges and Culverts
Foundation and Hatchway
Gutter and Curb
Storage Cellar
Small Warehouses
Spring House
Cement Blocks
Porch and Steps

Small Dam
Milk House
Ice House
Manure Pit
Septic Tank
Oil Storage Tank
Tennis Court
Inclosure Walls
Barn and Silo
Public Comfort Stations

Corn Crib
Poultry House
Smoke House
Hog House
Dipping Vat
Tanks and Troughs
Piers for Small Boats
Garden Furniture
Trimstone, Facades
Lamp Standards, etc.

Greenhouse
Coal Pocket
Posts and Walls
Walls, Sills and Lintels
Garages and Runways
Cement Stucco
Cement Chimneys and Fireplaces
Cold Weather Concreting
Warm Weather Concreting

Name.....

Address.....

MAILING CARD

Place
1-cent
Stamp
Here

ALPHA PORTLAND CEMENT CO.

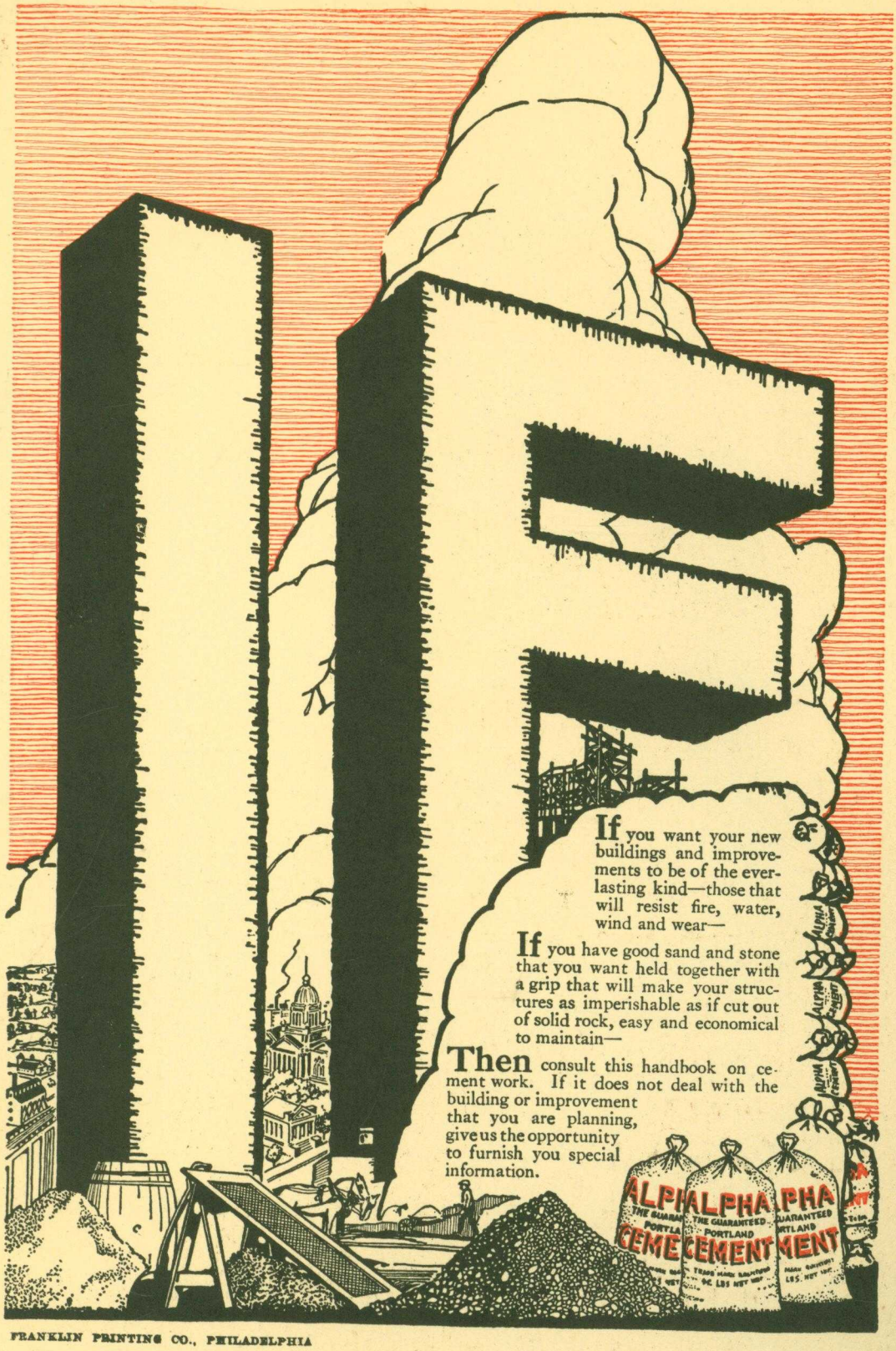
SERVICE DEPT. Easton, Penna.

MAILING CARD

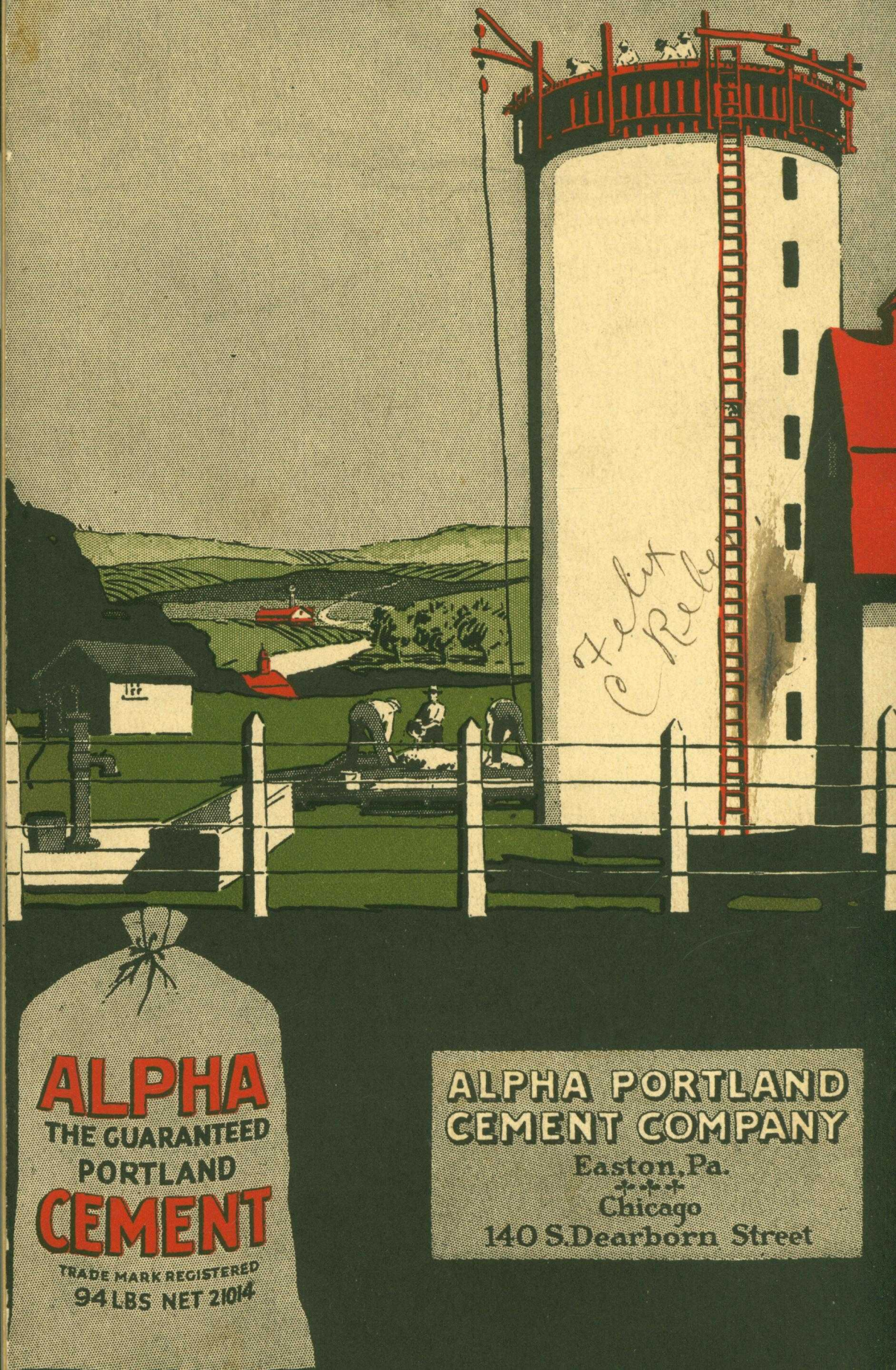
Place
1-cent
Stamp
Here

ALPHA PORTLAND CEMENT CO.

SERVICE DEPT. Easton, Penna.


If you want your new buildings and improvements to be of the everlasting kind—those that will resist fire, water, wind and wear—
If you have good sand and stone that you want held together with a grip that will make your structures as imperishable as if cut out of solid rock, easy and economical to maintain—
Then consult this handbook on cement work. If it does not deal with the building or improvement that you are planning, give us the opportunity to furnish you special information.
ALPHA
THE GUARANTEED
PORTLAND
CEMENT

FRANKLIN PRINTING CO., PHILADELPHIA



ALPHA PORTLAND CEMENT COMPANY

Easton, Pa.

Chicago

140 S. Dearborn Street